From damage to disaster: a study of vulnerability to flash flooding in urban Wadi Hadhramaut, Yemen.

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Abstract

This research is a study of the changing vulnerability of three towns in the Wadi Hadhramaut, Yemen, to flash flooding. The predominant construction material of the towns, Seiyun, Shibam and Tarim, is the sun-dried mud-brick, a seemingly impractical choice in an area where floods are expected annually. However, until recently, the vulnerability of the towns to flooding has been limited. The majority of the flood events in the Wadi Hadhramaut have caused little destruction within the towns, the damage being manifested in the collapse of a few houses. Reconstruction of damage caused by flooding has remained within the capability of the communities.

Until recently, the protection of the towns has been through the practice of building on the raised ground beneath the mountains and on islands of colluvial material defined by channels on the flood plain. Weirs and channels in the wadi bed guide and disperse the flood waters so that their destructive effect is reduced. Mitigation has been provided by aspects of house construction, and traditions of co-operation within the communities.

Unfortunately, as a result of the rapid and erratic process of urbanisation, the towns are becoming increasingly vulnerable to flash floods. The town planning principles of building on high ground and controlling flood waters have been affected by the pressing need to find more land on which to house the growing population. House construction has taken place at the edges of the flood channels. Agricultural lands that once absorbed flood waters have been developed into residential areas. Large suburbs have been developed in areas prone to inundation during major floods. These trends, coupled with the disruption caused by government intervention in community co-operation, have substantially increased the likelihood of a major flash flood causing a disaster in any one of these three towns.

Acknowledgements:

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I also would like to take this opportunity to thank the many people who have given me valuable assistance during the course of my research. Many thanks are due to Professor E. Anderson for his patience and criticism. I am also very grateful for the support and practical assistance of Dr. J. Watson, Dr. E. Murphy, Dr. G. Boughton, Professor T. Niblock, Professor T. Burt, and Dr. A. Kirk. I would like to thank Professors Layton and Sillitoe for permission to attend lectures and seminars in the Department of Anthropology. I am also thankful for the encouragement of the employees of the Middle East and Africa Desks, and grateful to the Yemen office of Oxfam for the opportunity to accompany them on a field trip to Shabwa. I have also benefited from the generosity of Mrs E Welch, Miss L Buchanan, Mrs C. Buchanan, and the Council Fund for Students Travelling Abroad. Thank you all very much.

I am extremely grateful to all those in Yemen who provided me with information and their opinions, trusting me to use them well. I have taken what they have given me and formed my own opinion. If there is to be any criticism of this work, it should fall at my feet rather than at theirs. If there be praise, then let it be for them for they sacrificed time, energy and sometimes their reputations to talk with me. I would, in particular, like to thank ʿOmar al-ʿAamery, Hassan BaaHashwaan, ʿAli al-BaHbuuH, ʿAbd al-Baary BaaRaJaa', and Atheer Najm. I am also appreciative of the permission given to me to root around in the libraries of UNDP and The World Bank in Sanaʿa'.

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Glossary

I have used many Arabic words and names throughout the text, usually because the Arabic word is more concise than the English phrase. Although the majority of the Arabic words are printed in italics, a few frequently occurring proper nouns remain in regular font. Transcription of the Arabic has necessitated the use of *H* (ح), *T* (ط), S (ص), ᶜ (ع) and ʻ (hamza). I have retained the local pronunciation of (ق) as *g*, desiring to keep local pronunciation in words specific to the region, as close to the original as possible. I have compromised on the transcription of *j* for (ج) despite the fact that in the Hadhramaut it is sometimes pronounced *y*. I felt that the potential confusion caused by such a radical change of letter was unnecessary. Long vowels are indicated by a doubling of the short vowel e.g. ᶜAidiid, pronounced ᶜAideed. I have, however, omitted to change wadi, which is recognised in English, into *waadi*. Similarly, I have not changed the names of the three towns into *Seiy'uun*, *Shibaam* and *Tariim* so that the reader may recognise them in other English texts. Arabic words that do not follow my method of transcription are given in quotations in the text.

al-ᶜadjuz: days of intense cold

al-Himma, a dense, dark green. The area of palm groves and fields to the north of Seiyun.

al-husum: the violent wind

al-lijaan: supervisor of the Muuzaᶜ and its sister weirs, Shibam

Azyab: wind blowing from the NE to the SW

baHri: from the south, the direction of the sea

Baladiyya: Local Authority

BatHaa' (also called *niis*): extremely fine gravel from the wadi bed

ᶜ*agd Intifaa':* "contract of benefit", the contract of occupancy given by the Socialist government to tenants.

ᶜ*agf*: a method of laying madar. The bricks are stacked vertically.

ᶜ*elb:* zizyphus spina Christi

Dabur: West Wind

daᶜif: weak ones: unskilled workers, merchants, artisans and traders forbidden to bear arms

dhiraᶜ -pl. *adhruᶜ*: measuring unit of approximately 45 cm

dikka pl. *dikuk*: foundation protections and step, constructed around the base of mud houses

fagouz: an edible gourd

gaama: a layer of bricks laid to the height of a man

gat: cathula edulis.

ghaim: mists

gharaq: a paste made of the same mud and *tibl* as *madar*.

Hadaj: a bitter and inedible gourd

Hadhaarim: people of the Hadhramaut

Hadhrami: of the Hadhramaut

Hadiida: a pointed metal float for applying thick *nuura* plasters

Hamiir: the pattern in which *madar* continue to dry. They are arranged like an ear of wheat, each *madra* on its edge

Hataiga: soap tree, the leaves of which are gathered, ground and used as a soap.

hawa': breeze

Hissi: well

idha baragat min al-gibla, tarafaᶜa fawg ya Taarif: If lightning flashes from the direction of the Qibla (direction of Mecca, north-west), then get up to the high ground you who live on the edge {of the mountain or valley}.

iHdhr min thalaatha, al-ᶜabd, al-thawr wa s-siyuul: Watch out for the slave, the bull, and the flood.

ISlaH: The Reform party, relatively hard-line Islamic.

ithl: tamarisk

jaᶜabuur: a type of tree the twigs and branches of which are used for making ceilings in *Hadhrami* houses.

jol pl. *jawlaat*, dual *jawlaan*: mountain plateau

kabs: the base upon which the walls of the house are built

Kathiiri: of the Kathiiri family, the former Sultan of Seiyun's family

khaayil: supervisor of the weirs, Duᶜaan.

kuut: watchtower

lajnat muᶜaalijat majaary wa adhraar as-siyuul: The Committee for the Repair of Watercourses and Flood Damage (of Tarim)

lakhm: dried shark meat

lijn: this tree bears leaves which are used to clean hair

Lijna li-difaa' as-shaᶜabi: Committee for the Defence of the People.

Maᶜaroudha: the method of laying *madar* in regular lines, with the narrowest edge on the outer and inner sides of the wall.

madra pl. *madar*: sun-dried mud-brick

maHgaT: a 3' by 6' bed of large cobbles set in concrete used for beating *nuura* to a paste

miSbaT: a 5'- 6' pole used at the *maHgaT* for beating *nuura.*

mithal or *miftal:* wooden frames shaped like open books

Mu'tammar: the General Peoples' Congress party, led by ᶜAli ᶜAbdullah SaaleH.

muᶜallim saas: foundation expert

Mudiriyya: Local Government district.

mulaT: a paste made of the same mud and *tibl* as *madar*

muuthar: five layers of *madar*, about 1 ½' thick

Muuzaᶜ: the 700m long stonework diversion weir above Shibam

Muzᶜaan: the E-shaped weir above Seiyun which divides flood waters into two parts

Nuh: Noah

nuktah; the rainy season

nuura: lime plaster or wash

Quᶜaiti: of the Quᶜaiti family, of the family of the Sultan of al-Mukalla and Shibam.

racca: salvadore persica

raim- pl. *riyuum:* roofs and roof terraces

Ramaad- (literally, ash). A plaster of pure lime mixed with ash.

Ramadhaan: the Muslim month of fasting.

Ramlat as-Sabatayn: Sands of the Two Shebas, the triangular patch of desert between the Western Massif and the Eastern Plateau.

riyah al-djanub or Djanub: South Wind

ar-Rubᶜ al-Khaali: the Empty Quarter, the desert shared by Saudi Arabia, Oman and Yemen

rooti: a single round of pitta bread

rushuusha: whitewash

ruus: the heads of the tributary wadis

sabayatayn: method of laying *madar* with the widest edges on the outside of the wall.

sabia wa maᶜaroudha: a method of laying *madar:* on the flat, three *madra* are laid horizontally (*maᶜaroudha*), next to them are two *madar* laid vertically (*sabayatayn*).

Sail as-Sabaᶜ: the flood that occurred on the seventh day of *Ramadhaan*, 1955, Seiyun

sail hamim: a powerful, strong and noisy flood

sail: flood

samum: hot wind

Sanaʿaani: of Sanaʿa', the capital of Yemen

Saratan: Cancer

seil pl. *seiyuul*: flood

Seiyuuni: of Seiyun

seiyyid pl. *saada*: religious elite

Shaara bilaa baHry kamaa bab artakab ma luh gawaam: "Rains (and floods) without the *BaHri* wind, Are like a door set up without supports."

Shaariʿ al-Jazaa'ir: Algeria Street

Shabwaani: of the Governorate of Shabwa

Shibaami: "of Shibam"

shimal: North Winds

shuHura pl. *shuHraa:* dry waterfalls slightly below the level of the cliff face

sibakh: Saline mud

Sik: the last weir in the series that protect Shibam

sufrah: sluice plank

siisibaan: prosopis

suur: town wall

taliiS: a *zubr* mud and chaff plaster

Taraga milis, a very smooth lime plaster

Taraga: *nuura* mixed with sand and cement

Taraga: *nuura* mixed only with *batHaa.*

thagaafa: culture

tibl: chopped straw, chaff

TiHaama: the coastal plain in the west of Yemen.

Tiin: mud

wadi pl. *wadiaan*: valley

wakad gabiila: a tribal *wakad*

wakad: corvée, compulsory labour

Ya Hawl Hawlaa!: Hurrah!

zay sukr fi shaahy: like sugar in tea

zubr: mud with a high proportion of clay

Acronyms:

FAO: Food and Agriculture Organisation of the United Nations

NGO: Non-Governmental Organisation

PDRY: People's Democratic Republic of Yemen

SOGREAH: a French consulting firm

UNDP: United Nations Development Programme

UNESCO: United Nations High Commissioner for Refugees

UNHCR: United Nations Educational, Scientific and Cultural Organisation

WHAP: Wadi Hadhramaut Agricultural Project

YAR: Yemen Arab Republic

YD: Yemeni Dinar (YD 1 = 1,000 fils) currency of the former PDRY.

yr.: Yemeni Riyal, the local currency.

YSP: Yemeni Socialist Party

This thesis is the result of my own work, never before submitted to any institution. Material from published or unpublished work of others referred to in the thesis is credited to the author in question in the text. This thesis is approximately 40,000 words in length.

Introduction

In 1954, the Kathiiri Sultan left the Wadi[i] Hadhramaut for the first time in his life to meet Queen Elizabeth II who was staying in the Crescent Hotel in ʿAden on the last leg of her tour of the Commonwealth[1]. Flying low over the sparkling blue harbour on the approach to the landing strip, the Sultan saw the sea for the first time and mistook it for a flood. Terrified, he swore never to return to ʿAden unless the "flood" had subsided[2].

Flash floods are part of the *Hadhrami*[ii] legend. The creation of the Wadi Hadhramaut is linked, in folklore, to Noah's flood[3]. Proverbs sum up local lore on rain and floods. Even today, epic songs describing floods in the valley are composed and sung, urban myths such as the one above are retold. Flooding is inextricably mixed with life. However, increased urbanisation and the gradual decline of the agricultural sector in the valley are changing the relationship between the community and the floods. Floods now pose a threat where they once were beneficial. The aim of this thesis is to analyse selected social and political structures of the urban Wadi Hadhramaut that have altered this relationship, and to try and ascertain whether these structures have increased the likelihood of disaster in the event of a flood. This study will focus upon the three towns of Seiyun, Shibam and Tarim.

At the moment, the three towns under discussion, Shibam, Seiyun and Tarim, suffer damage rather than disaster through the effects of flash flooding. In year to year floods, even significant ones, the damage inflicted upon a town by the flood is usually minimal and affects only a few families. If a flood affects a few families the situation cannot be called a disaster, a disaster is a far larger concept than a personal tragedy. Few people die, few houses are destroyed, the economy is barely affected and the country as a whole is unaffected by flash flooding in these three towns. The vital role of town planning to the prevention of disaster has so far protected the three towns from major disaster. The principles used in agriculture; diversion of spate waters and house construction on the higher, barren areas, still provide a fairly secure base on which to build towns. Traditional methods of house construction are still in use and are important in the mitigation of disaster.

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[i] *wadi* pl. *wadiaan* "valley".
[ii] *Hadhrami* "of the Hadhramaut".

Currently, coping with the results of the flash flooding remain within the expectations, experience and capabilities of community.

Nevertheless, the ever-present potential of the hazard, flash flooding, means that prevention and mitigation must continue to be part of the development of the three towns. Since the main methods of prevention and mitigation of the area are in town planning and house construction, the likelihood of an increase in vulnerability through the increase in urbanisation is a threat that needs addressing. Indeed, the rapid rate of urbanisation that started with a housing boom in the late 1970s, and recently augmented by a sudden freedom in the land market, has put pressure on available land. The principles of flood avoidance and utilisation are being ignored in the search for additional areas for construction. Channels that carry waters in times of flood are being constricted. Agricultural areas that once absorbed and put to use the spate waters are being blocked off, houses are being built on the cleared land. Wasteland areas prone to flooding have been developed into large suburbs. Stonework defences that divert the flood waters are in disrepair. Finally, just as the structure of the town has changed in response to the move from an agriculture-based society to a service-oriented society, so too have the traditions. The implications of all these changes are very important. Having so far mitigated against the potentially disastrous effects of flash flooding, the three towns now find themselves in a position of drastically increased vulnerability to floods. The event of a major flood occurring in any one of these towns is likely to result in a disaster.

The thesis is divided into three parts:

The social and political background to the subject is described in chapter 2. Chapter 3 describes the hazard to which the communities are vulnerable, flash flooding. It also includes a summary and analysis of the floods that have occurred throughout the history of settlement in the Wadi Hadhramaut.

Since this thesis is concerned with the survival of the three towns and their communities despite the threat of flash flooding, it is important to examine traditional methods of prevention and mitigation. These are described and discussed in chapters 4, 5 and 6. The key preventative measure discussed is the avoidance of floods through the careful town planning upon raised areas at the edge of the valley and upon the islands of the alluvial fan defined by a network of flood channels. Methods of mitigation include aspects of sun-dried mud-brick construction, the methods used and the integral qualities of the materials. Crucial

to the long-term security of the three towns is the role of folklore in the perpetuation, in the community, of knowledge connected to flash flooding.

Having elaborated upon the issues relating to the protection of the towns, chapters 7 and 8 show the relationship between the communities of the three towns and flooding to be in the process of change. This change is the result of the rapid and erratic urbanisation of the area and the gradual dislocation of the communities from agricultural practices. The consequence of the increasing crush on land that has been proven safe from flooding, is the pervasive encroachment of housing towards the flood dispersal channels and upon agricultural land. The establishment of large suburbs, without adequate protective measures, on wasteland prone to inundation has substantially increased the numbers of residents vulnerable to flash flooding. It is further shown that the effect of urbanisation upon social unity has seriously handicapped the response of the community to a disaster caused by flooding, thereby affecting the processes of relief and rehabilitation. It is the intent of this thesis to prove that these worrying trends in urbanisation have considerably increased the potential of the three towns to suffer disaster.

Addressing the causes of disaster is currently a pertinent issue both internationally and within Yemen. In December 1989, the United Nations adopted Resolution 44/236 which proposed that the 1990s should become the International Decade for Natural Disasters Reduction[4]. The objective of the decade is to

> "reduce through concerted international action, especially in developing countries, the loss of life, property damage and social and economic disruptions caused by natural disasters such as earthquakes, windstorms, tsunamis, floods, landslides, volcanic eruptions, wildfires, grasshopper and locust infestations, drought and desertification and other calamities of natural origin."[5]

Third World countries, such as Yemen, which are dependant on aid for development purposes could be seen to be living in a state of permanent disaster. A disaster that is triggered by a natural hazard exacerbates the situation, increasing debt and dependency, and limiting ability to reconstruct. Development is also hampered by the reallocation of aid, expertise and non-governmental organisation (NGO) assistance to the rehabilitation of the afflicted community. The damage caused by the widespread flooding of June 1996 in many areas of Yemen served to focus the attentions, for a while at least, of the Yemeni government and the NGOs working in the country, on the defence of those vulnerable to flash flooding, and the overall development of the country.

The United Nations publication, Guidelines for Disaster Prevention, suggests that "The first and most basic problems in the field of disaster prevention are those related to planning, construction and the management of human settlements."[6]. Linking the rate of urbanisation to the augmented potential for disaster has particular relevance in the light of the rapid rise in the urban populations, particularly in Third World countries, through high birth rates and rural to urban migration. Yemen is no exception to this trend, having one of the world's highest rates of population growth[iii] and correspondingly rapid city expansion. The congregation of increasing numbers of people in a risky area obviously increases the likelihood of a hazard inflicting greater damage.

In response to the need for study on the connections between population growth, urbanisation and vulnerability to natural hazards in the Yemen, this thesis represents an original contribution to the field of disaster prevention and mitigation. It documents for the first time, the relationship between the residents of the three main towns in the Wadi Hadhramaut and flash flooding. Through the extensive use of primary sources, I have been able to ascertain the individual roles of mud-brick architecture, town planning and folklore in the limitation of the destructive effects of the flood hazard. Although all three aspects of the study have been researched by other academics, this is the first time that the important links between them have been studied. Furthermore, the emphasis of this thesis on the principle town in the Wadi Hadhramaut, Seiyun, is highly unusual. The extraordinary architectural excellence of Tarim and Shibam, has provided more inspiration to researchers and travellers than has the relatively dull town of Seiyun. However, it is in Seiyun that the rate of urbanisation has been most extensive, and it is in Seiyun that potential for disaster has most rapidly increased. This is the also first research upon regional practices of town planning to be completed since the building boom that followed unification with the Yemen Arab Republic in 1990.

[iii] Currently estimated at 3.4% per year (EIU Country Profile Oman/ Yemen, 1996/97, p. 42)

References:

[1] Keesing's Contemporary Archives, Weekly Diary of World-Events; 1952-1954, vol. n°. IX. (Bristol, Keesing's Publications Ltd. (of London)) p. 13575.
[2] Conversation with ʿOmar al-ʿAaamery, 3/3/97
[3] H. Ingrams, Arabia and the Isles. (John Murray Ltd., 1952) p. 163
[4] K. Smith, Environmental Hazards. Assessing risk and reducing disaster.
[5] Ibid.
[6] United Nations: Guidelines for Disaster Prevention, vol. 1. Pre-Disaster Physical Planning of Human Settlements, (Geneva, 1976) p. 5.

Chapter 1

Methodology

This thesis aims to show that, although Seiyun, Tarim and Shibam usually suffer damage rather than disaster as a result of flash flooding, through the process of urbanisation, the possibility of disaster is increasing as the three towns expand into areas of potential risk. In order to be able to assess whether there has been an increase in vulnerability to the hazard of flash flooding, it is important to define what is meant by damage, disaster and vulnerability.

A distinction must be made between the hazard and a disaster. I shall use the word hazard to mean a (source of) danger or risk (in this case, flooding), and disaster, a great or sudden misfortune[1]. That a hazard may occur does not automatically ensure that a disaster will ensue. The factor that turns the hazard into a disaster is the extent of human vulnerability to that hazard. Human vulnerability is the key in the definition of a disaster[2], for it must not be assumed that all hazards affect humans. "A disaster should be defined on the basis of its human consequences, not on the phenomenon that caused it"[3]. Vulnerability carries the implication that a community is capable of being physically or emotionally wounded or hurt[4]. It is characterised by the restriction of access to resources, for example power, money and education, although it is not always the result of discrimination or inequality[5]. Communities can be put in a position of vulnerability through economic, political and cultural structures, and a psychological impotence brought about by status and past events[i].

The extent of the disaster is therefore dependent on the extent of people's vulnerability to the hazard. A small natural hazard can have implications far beyond expectations if a large group of people are vulnerable to that hazard. Hazards can sometimes be socially selective, dependant on variations in vulnerability within the community. A major disaster has repercussions outside the affected community or area. These communities may not have been vulnerable to the hazard itself, but vulnerable to the effects of the reallocation of resources to the stricken area.

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[i] Blaikie *et al.* call it "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of the natural hazard." (Blaikie, Davis, Cannon, Wisner, 1994).

Demographers like to define a disaster by the number of illnesses and deaths over normal expectations[6]. This tidemark of "normal expectations" is useful, for the value and amount of property lost, the social and economic change necessary, and the amount of fear and stress caused by the crisis can also be held up to the line of the normal expectations of the community. The word "expectation" carries with it the implication that the community is prepared for the hazard and has the ability to reconstruct after the hazard has past. Vital to this definition is the need for external aid. The aftermath of a hazard that overwhelms the community's structures and facilities to the extent that aid from outside the community or country is essential for reconstruction may be called a disaster. The longer it takes for the community to return to its pre-disaster state or some modified version of it, the greater the disaster.

The definition of damage, therefore, encompasses the effects of flash floods that, while they affect the individual families involved, do not affect the whole community, town or area. Personal misfortunes do not affect the long-term economic and social development of the region for such losses remain within the expectations of the community. Implicit in the low levels of loss are correspondingly low levels of vulnerability.

Urban *Hadhaarim* tend to define a disaster in terms of the numbers of houses destroyed by the heavy rainfall and the subsequent flood, rather than the numbers of hectares of topsoil (or any other such agricultural measurement) destroyed. This is interesting, for it demonstrates the high priority a house has for urban *Hadhaarim* and their personal interpretation of the risks of a flash flood. As a measure of a disaster it is useful in the light of the increasing urbanisation in the Wadi Hadhramaut. Should trading and industry catch up with urbanisation in the future, the emphasis on houses is likely to be reduced, but at the moment the majority of the buildings in the towns are residential. Since houses in the area are made of sun-dried mud-brick, their inherent vulnerability in the face of a flash flood provides a good measure of the communities' vulnerability to the floods.

Difficulties Encountered

Key pieces of material which would have benefited the research were unobtainable, their absence also preventing me from being able to analyse, in hydrological terms, the increased vulnerability of the three communities to flooding. Reasons for my inability to obtain this information vary, but I shall attempt to summarise them below.

Rainfall data: Two meteorological stations exist in Seiyun: at the Wadi Hadhramaut Agricultural Project (WHAP), and the airport. I asked for printouts on rainfall at both of these stations. WHAP were able to give me patchy data for the 1990s, the airport were only able to give me monthly rainfall data for 1990 to 1994. Data in the airport are compiled and collated by hand. Two men had to copy, by hand, the collected data in order to give me the information I requested. There were no other copying facilities. To copy all the information I needed would have taken days, a task I was reluctant to ask of them. Data from 1994 to 1997 had not yet been collated and therefore inaccessible to me. Similarly, there exists very little data on flood events. Most reports on floods lack even a specific date for the flood, records of discharge rates and duration are also estimated.

Maps: I was unable to locate any maps of the Wadi Hadhramaut network that showed villages, towns and the flood routes. The offices of local government did not have one, neither did WHAP, the Office of Housing and Town Planning, the Agriculture Department or the offices of the Agricultural Extension Project.
There is only one town plan of Seiyun in the area. Located in the Office of Housing and Town Planning, it is the size of a room, utterly impossible to photocopy both practically and legally. Employees of the Office were very wary of me at first, it took about two weeks of persistence and the presentation of two letters before they would even let me see the map. I was also unable to obtain town plans of Tarim or Shibam, although that of Shibam was of less importance, having only one water channel running through it.

Channel widths and gradients: In order to be able to measure the channels that carry flood waters in the three towns of the Wadi Hadhramaut, I would have needed technical equipment, many months and many assistants. A car would also have been useful, as would a plan of the towns. Such information on the

channels does not exist in any reports or documents, except perhaps the Cuban document on town planning in the region. Unfortunately, I was unable to obtain this report.

Cuban report: This is the only report and analysis of town planning in the area. Its emphasis is on Seiyun, about which little has ever been written. The research for the report was undertaken shortly before and after Unification by a Cuban team. No-one in the Seiyun office had ever seen the report, even seven years after its completion. ʿAbd al-Baary M. BaaRayaa' of the Housing Office had seen one of the maps in al-Mukalla by accident but could not locate the reports. Neither had the Ministry of Planning and Development in Sanaʿa' a copy of the report. Apparently, it was held in another building on the other side of the capital city, and written only in Spanish.

Numbers of houses built per year: Records for the number of houses built per year in the three towns are kept in the Office of Housing and Town Planning in Seiyun. They are not collated and are out of sequence, and kept in jumbled foolscap files. In its current state, the information is inaccessible to employees of the Office. I would have had to spend weeks sifting through the files to compile my own data. The information on houses constructed before Unification has been thrown away.

Specific measurements for how close a house is allowed to be built to a channel: No-one could give me any indication on any policy related to this issue, except that the measurements depend on the channel.

Flood reports from the 1980s: The majority of the reports written about floods that occurred in the 1980s were impossible to obtain. Apparently, such reports do exist. The World Bank and UNDP (United Nations Development Programme) were surprised to find that they had no copies of the reports in their libraries. It was suggested to me that I ask at the Ministry of Planning and Development in Sanaʿa' where a special unit had been set up to deal with flooding and emergencies. The head of the unit, Khaalid Afiif, had no documents, no information other than a few reports on the June 1996 floods. I already had these reports. He and I asked the Deputy General of the Agriculture Department in the Ministry where we might find the documents. According to him, these reports were lost or stolen during the move of the

Ministry from ʿAden to Sanaʿa' after Unification. He had not seen them since that time.

The main branches of the administration are located in Seiyun, the capital of the Wadi Hadhramaut. I had hoped, therefore, to collect most information in Seiyun so that I did not have to create further networks of people in Tarim, Shibam and al-HawTa (the administrative town for Shibam). In some respects this was a mistake. It is likely that much information relating to all three towns could have been found exclusively in Seiyun and I persisted in trying to extract it, but was repeatedly told to return another day. I later found out that town administrative branches often work independently of each other.

Research Methods

The majority of my material has been gathered through interviews and conversations with residents of the three towns. I also spent time observing construction methods, and made excursions to areas of particular vulnerability. Visits to valleys in the governorate of Shabwa that had suffered greatly in the floods of June 1996, provided me with material for comparison by showing me the consequences of extensive and severe flash flooding on individual families and whole communities.

My reliance on oral information was determined, in part, by the lack of written resources on the Wadi Hadhramaut. Tarim and Shibam have received some attention as a result of their extraordinary architectural heritage, very little has been written about the town of Seiyun. Information on the urban or social implications of flash flooding in the area was sparse. The existing written information on floods in Yemen concentrates, almost entirely, on damage to the agricultural sector rather than to urban areas. In doing so it reflects the greater vulnerability of agricultural areas to floods[ii].

I used Arabic in most conversations. As it is not my first language, this had its limitations. However, my Arabic did improve with the assimilation of new

[ii] This greater vulnerability was clearly demonstrated in the floods of June 1996 and their aftermath (cf. Appendix 1).

vocabulary and new dialects[iii]. My familiarity with the language enabled me to converse with people with knowledge to which I would not otherwise have had access. The exercise book that I always carried, and in which I took notes throughout every conversation, was a useful resource for sketches, new words and explanations. Although I frequently carried a tape recorder with me, I rarely used it. Neither the interviewee or I felt comfortable discussing sensitive issues in front of a third party, the tape recorder. Those I did record emphasised that I was not to let anyone know that the tape existed. The exercise book was by far the better prop for it also gave me authority in the town by marking me as a serious researcher.

Despite the societal restrictions, I believe that I was able to achieve a fair balance of conversations with people of different occupations, status and experience, although I did interview more men in the Wadi Hadhramaut than I did women. This was unavoidable; the vast majority of the town-planners and surveyors, local government employees, local historians and engineers were male. I tried to redress the balance during a three week period spent in the neighbouring governorate of Shabwa with the Oxfam engineer, Atheer Najm, accompanying him on his mission tours up barren wadis that once were fertile and productive. I talked with both men and women who had lost homes and livelihoods to the floods of June 1996.

Although the lack of recorded information on the subject of flash flooding in urban Wadi Hadhramaut was inconvenient, it does provide a certain originality to this piece of research. Through interviews, I was able to gather information that is unavailable in written form. This includes personal recollections of flood events and related family stories, explanations and sketches of building methods, concepts of disaster, town planning regulations or lack of them, fears of the communities and the social implications of political action. I have interviewed people who have lived their whole lives in towns that are regularly subjected to flash flooding, and who have witnessed the progress of urbanisation and the accompanying trends of watercourse encroachment. Communication with people who have had first-hand experience of flooding is vital for a social study of flash flooding.

[iii] The *Hadhrami* and *Shabwaani* (of the Hadhramaut and of Shabwa) dialects are different from each other in accent and vocabulary, and different again from the *Sanaʿaani* (of Sanaʿa') dialect that I had learnt as an undergraduate.

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Chapter 2

Social and Political Background

The Republic of Yemen is situated on the tip of the Arabian Peninsula. The northern border is shared (and disputed) with Saudi Arabia, the eastern border is shared with Oman. The Red and Arabian Seas and the Gulf of 'Aden define the coastline (see figure 1[1]). A land of ancient civilisations, in its present form the Republic of Yemen is a relatively new country. On the 22nd May 1990, Yemen was united for the first time in its history when the People's Democratic Republic of Yemen (in the south) and the Yemen Arab Republic (north) merged to form the Republic of Yemen. To this new union, the two countries brought a catalogue of economic problems and underdevelopment, and clashing political viewpoints.

The underdevelopment of a country has serious implications in the issues of vulnerability to natural hazards and disaster relief. The UNDP has recorded that Yemen is one of the least developed countries in the world[2]. The provision of potable water, education, health services, and utilities is high on the agenda of most Third World countries, Yemen included. Population growth puts further pressure upon the money available to the country, Yemen has a very high rate of population growth at 3.4% per year[3]. The lack of these services frequently increases the extent of vulnerability to a natural hazard. In the event of disaster, money is diverted from development to disaster relief and reconstruction, thereby wiping out prospects for improvement in the quality of life and the economy in the country. When, as in Yemen, the natural hazard is a recurrent one, the repeated diversion of money needed for relief and rehabilitation from development is a major handicap.

Northern Yemen has been, and still is, characterised by its isolation, underdevelopment and tribal nature. These characteristics have evolved and been maintained by the mountainous landscape which makes communication difficult. Even today, the country has few asphalted roads in rural areas. In addition to the isolation enforced by the landscape, political reasons kept North Yemen relatively isolated from outside influences and development. Until 1962, North Yemen was an Imamate, in this century led by a religious leaders from the Mutawakkil family, AHmed and YaHya. Both AHmed and YaHya deliberately kept the country closed

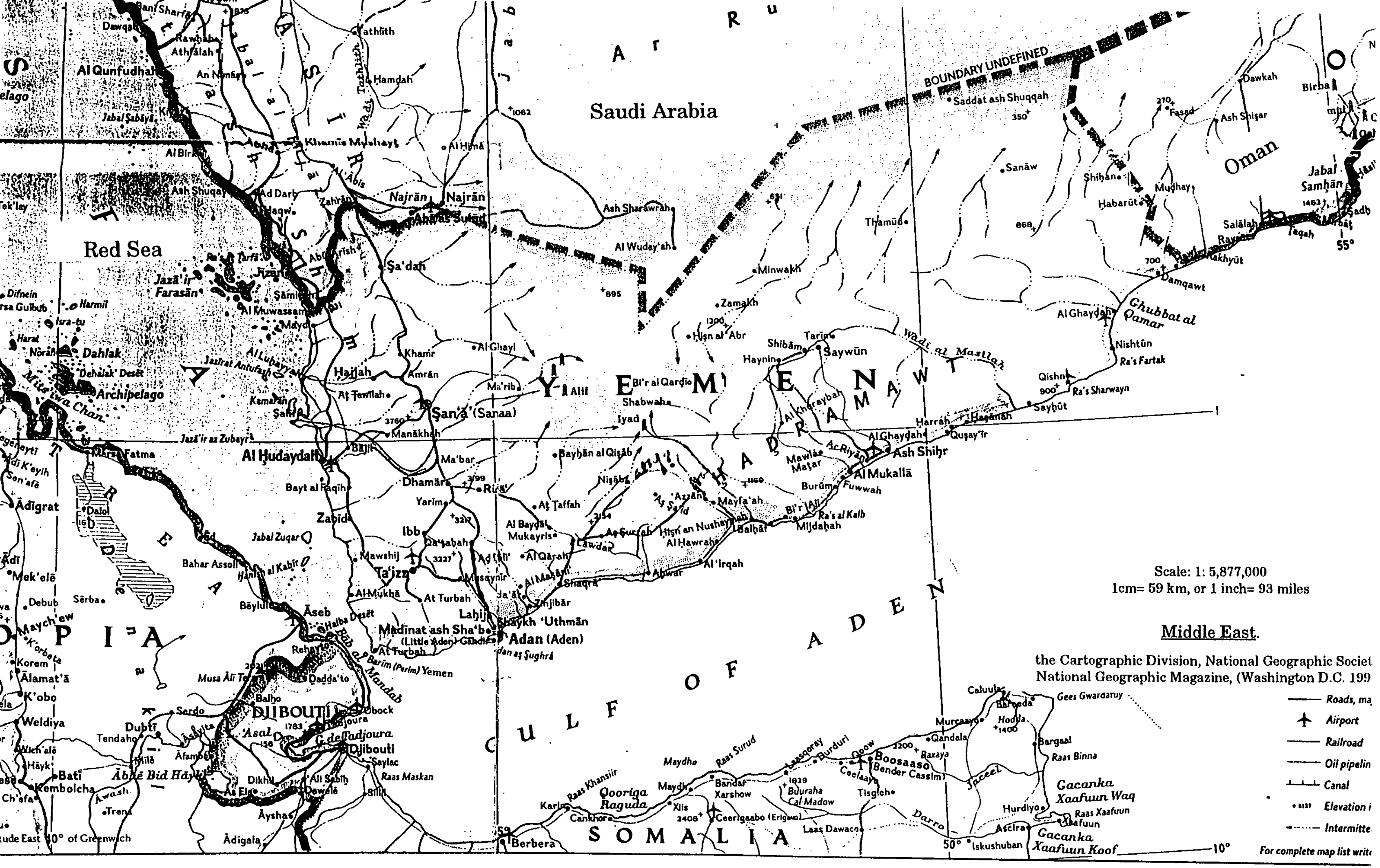


Fig. 1. Map of the Republic of Yemen.

to foreigners. The Imamate period ended in 1962 when a group of republicans, led by the military, overthrew AHmed and renamed the country the Yemen Arab Republic[4]. Civil war, with support from Saudi Arabia and Egypt on opposing sides, continued throughout the 1960s[5]. The current president of the Republic of Yemen, Lieutenant-Colonel ʿAli ʿAbdullah SaaleH, became leader in 1978 following a succession of short-lived presidencies[6]. It is generally considered that the issue of isolation and development began to be addressed in the 1970s, although much still has to be achieved in education, water supply and health. Tribal problems still afflict northern Yemen, with 46 internationals kidnapped by the end of October 1997[7] and inter-tribal scuffles around the time of the elections of April 1997.

South Yemen grabbed its independence in 1967 when nationalist forces pushed out the British colonial presence that had occupied ʿAden since 1839. Before independence, the country was suffering from a dramatic imbalance in development between the capital, ʿAden, and the rural areas in the rest of the country. The port of ʿAden and the services required to maintain it had been supported by the British. Much of the hinterland still lacked basic utilities as the country's lack of natural resources did not tempt the British to overcome the inter-tribal disputes that had so far precluded development. The most important inroad into the stabilisation of the area by the British was a series of advisory treaties with the Sultans, of which the first with the Quʿaiti Sultan was signed in 1937, the last in 1957[8i]. Naturally, with the expulsion of the British presence, these treaties were invalidated. It was upon this unstable, underdeveloped base that the new government had to build. The problems inherited by the new rulers of South Arabia were further compounded by the bankruptcy and unemployment which had occurred on the departure of the British. The loss of British aid and the opportunities for employment that their military and commercial presence had provided[9] were exacerbated by the closure of the Suez Canal during, and in the aftermath of, the Six-Day War. The fall in the numbers of ships passing through ʿAden almost emptied the once-busy port.

The new government was heavily influenced by the ideologies of socialism and Nasserism that were popular at the time in the Arab world. One of the aims of the government was to nationalise the whole economy, and to create a democratic republic in which the peasant and the working class intellectual were to play the

[i] Two sultanates never reached agreement with the British (Lackner, 1985)

most important role in the fight against foreign influences and exploitation[10ii]. Shortly after accession, all sectors of the economy were nationalised, as were all foreign assets. Private land holdings also came under the scrutiny of the new leadership. The second Agrarian Reform Law, passed in 1970, ordered the seizure of all lands once owned by former rulers and those attached to the old regime. Land holdings above the levels of ownership permitted by the new government were requisitioned. Compensation was to be paid over a period of 25 years[11]. In 1970, the country was renamed the People's Democratic Republic of Yemen[12].

However, rather than distancing the country from foreign influences, the new republic changed allegiances. In 1969, government ministers sought funding for their development policies by sending delegations to socialist countries such as China, Cuba and Russia[13]. Foreign assistance was particularly necessary to the impoverished country because the expensive program of development was made more costly by the fact that the country was so sparsely populated. In a country of about 333,000 sq. km. the majority of the 2 million inhabitants (1980s figures) lived outside the capital[iii], making the average population density of five inhabitants per square kilometre[14]. The process of development was both helped and hindered by the migration of thousands of men of working age to the Gulf and Saudi Arabia, particularly during the oil boom of the 1970s. The foreign exchange that was brought into the country was vital, as were the independent efforts of the extended families to invest in their villages with remittance money. Unfortunately, the loss of labour to the oil states was a handicap to the development of the country. Corresponding with expenditure on development, the country had taken great strides in education and services by the middle of the 1980s. In the years 1974/ 75 YD, 19.6 million[iv] was allocated to development, in 1980, YD 66.7 million was spent[15].

[ii] In the early 1970s, the NLF (National Liberation Front) proclaimed that "All political in the PDRY is rested in the working people.....The historical role of the working class moves upwards and they become ultimately the leading class." (Lackner, 1985)

[iii] In the 1973 census it was reported that 66% of the total population of the PDRY lived in rural areas (UN, 1981).

[iv] YD = Yemeni Dinar. One YD = 1,000 fils. Between February 1973 and the January 1980, one YD = US $2.90 and US $1 = YD 0.345 (The World Bank, 1980)

United Yemen

Although historically the relationship between North and South Yemen has been volatile, as far back as 1972 it was agreed that the two countries should one day unite[16]. The eventual unification was brought about for economic and political reasons. The emergence of an ideologically less extreme leadership in the South after the civil war of 1986 made potential co-operation possible. Both political leaderships believed that they would benefit from the popularity engendered by unification[17]. The collapse of the Soviet Union and the end of the Cold War in 1989, followed by the loss of aid from Socialist countries forced the PDRY to face its large external debt[18]. This financial insecurity was key to the rapid unification of the two countries and the discovery of oil on the border between them was an important incentive to their peaceful unification.

The country is now divided into seventeen governorates (administrative regions), the majority of which are in the north of the country[v]. The governorate of al-Hudayda is on the coastal plain that lies between the mountains of the Western Massif and the Red Sea. Into the central mountain range of the Western Massif are the governorates of Hajja, al-MaHwiit and Sanaʿa', the latter encompassing and including the capital of the country, Sanaʿa'. In the north of the mountain range is Saʿada, and to the south are the governorates of Dhamaar, Ibb and Taʿiz. South-east of this fertile and highly-populated region is the governorate of al-Baydha. The governorate of LaHej is on the southern coastal plain, at the base of the spine that is the Western Massif. The tiny governorate of ʿAden surrounds and includes the volcanic outcrop on the coast around which the city and port of ʿAden are built. East of LaHej and ʿAden is the governorate of Abyan. In the mid-east of the country there is a triangle of desert, the Ramlat as-Sabatayn (Sands of the Two Shebas), two sides of which are edged by mountains of the Western Massif and the Eastern Plateau. To the north-west of the sands are the governorates of al-Jawf and Maarib, to the south and east, Shabwa. East of Shabwa is the governorate of Hadhramaut, a cross-section of the country that includes part of the Eastern Plateau, deeply-incised valleys, coastal plain and desert. The most remote governorate is al-MaHra in the far east of the country.

[v] The governorates of the former Yemen Arab Republic are; Saʿada, Hajja, al-MaHwiit, Sanaʿa', al-Jawf, Maarib, al-Hudayda, Dhamaar, Ibb, al-Baydha, and Taʿiz. The former southern state of the People's Democratic Republic of Yemen (PDRY) had six governorates: ʿAden, LaHej, Abyan, Shabwa, Hadhramaut and al-MaHra.

The present form of government is officially a multi-party democracy[19]. However, in influence the numerically[vi] and militarily superior tribal north has overwhelmed the socialist leaning of the former PDRY. Before the civil war of January to July 1994, the country was ruled by a coalition of the *Mu'tammar* (General Peoples' Congress- mostly of the north), the Socialist (Yemeni Socialist Party- southern) and the *ISlaH* (mostly northern) parties, with the presidency taken by ʿAli ʿAbdullah SaaleH of the *Mu'tammar*, and the vice-presidency by ʿAli Saalim al-Baidh (YSP)[20]. Following the defeat of the southern troops by the north, the Socialists were ousted and were replaced by members of the *ISlaH*, a relatively hard-line Islamic party who had co-operated with the north. Since the end of the war, tension between the north and south has decreased, although it still has implications for economic and political orientation. In the absence of any effective opposition during the second and most recent elections of April 1997, the powerful position of the *Mu'tammar* party was consolidated. Votes cast for the other parties were dominated by protest votes, and many in the south boycotted the elections[vii]. A significant but unknown amount of money is used to encourage tribal co-operation with the government[21]. As tribes in the south were mostly rendered impotent by a law passed during the Socialist era that forbade the carrying of arms and the resolution of disputes without government involvement[viii], it is the northern tribes that benefit from the peacemaking payoffs issued by the government. The appointment of ministers to government posts are often influenced by tribal allegiance[22], resulting in an imbalance of power in government between the tribal north and the south. The relative backwardness, and the location of the burgeoning capital in the north have meant that allocation of money for development has had a northern bias.

Although the agricultural sector employs nearly two thirds of the workforce[23] it contributes little to the economy which is dominated by the services sector[24]. Almost all agricultural produce is consumed domestically[25] and low levels of productivity keep contributions of the agricultural sector to only 18% of the GDP in 1996[26ix]. Unification, far from being the solution to economic problems, has been a further encumbrance to development of the economy. The new state inherited the debts of the South[x], the burden of Socialist loss-making schemes[27] and has

[vi] The majority of the 15.3 million people (The World Bank, Report no. 15158-YEM, 1996) live in the western mountains, many of them in the rapidly growing capital, Sanaʿa'. In comparison, the six governorates of the former PDRY are the least populated areas of the country. (FAO, 1996).
[vii] Personal communication in the Wadi Hadhramaut and ʿAden, January - June, 1997.
[viii] March, 1968 Tribal Reconciliation Decree (Lackner, 1985)
[ix] The commercial sector contributes 14%, manufacturing pitches in with 12%, and oil and gas provide a mere 7% of the GDP (Rahiim, 1996).
[x] Despite its smaller economy, by the end of 1989 South Yemen owed $2.5 billion, North Yemen owed $3.3 bn (EIU, Country Report, Oman/ Yemen, 1996/97. p. 73)

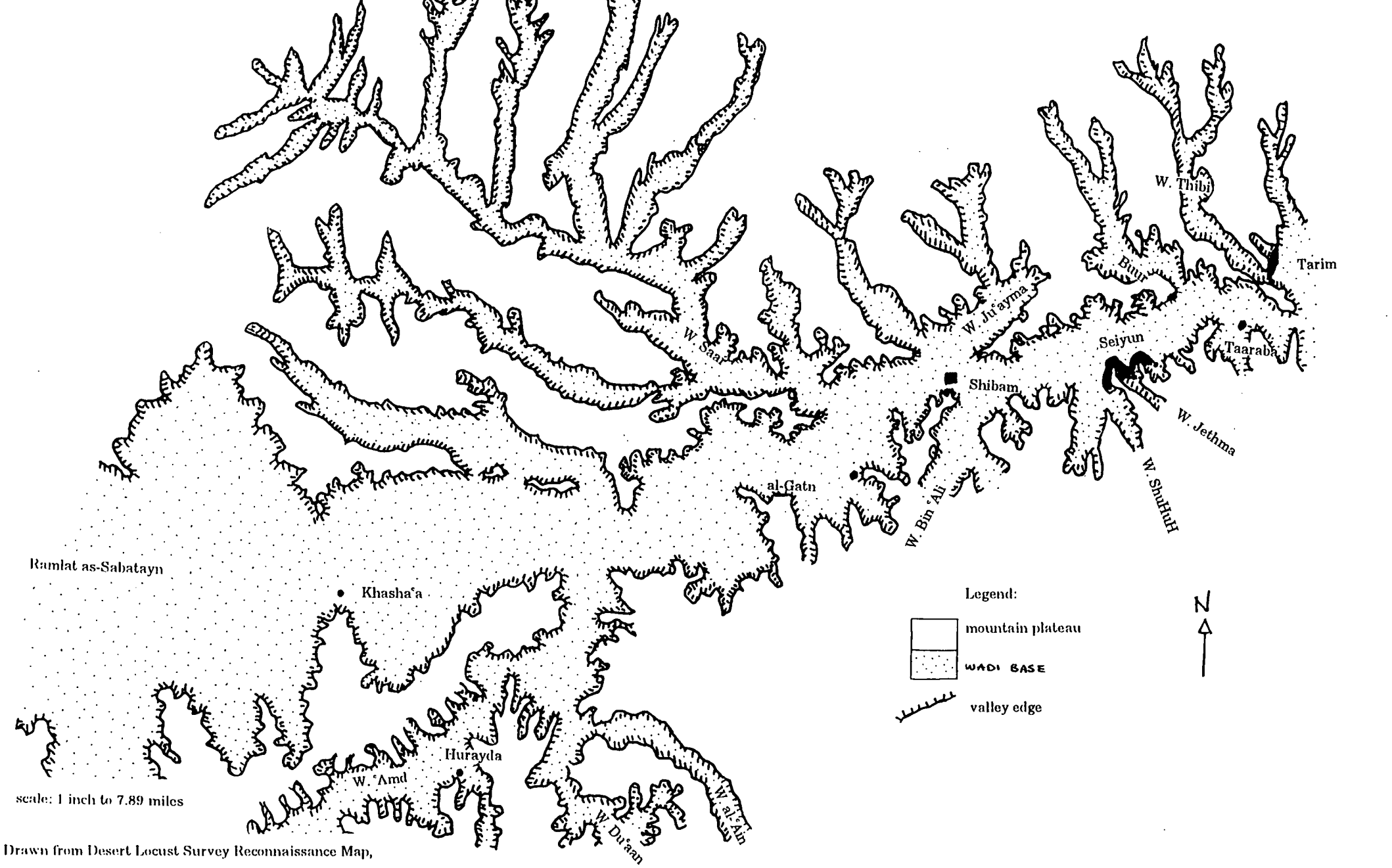
augmented government spending by merging the two civil services. Yemen's stance in the 1991 Gulf War resulted in the forced repatriation of almost a million Yemeni workers from the Gulf and Saudi Arabia, between 8 and 10% of the population[28]. The loss of substantial remittances, the strain put on the labour market and the loss of aid from Gulf states have compounded the problems with the economy. Furthermore, the civil war of spring 1994 ensured a reallocation of money to the defence budget and repairs to the damaged infrastructure[29]. From 1990-94, inflation averaged 58% p/a, although it dropped in 1996 to 48%[30]. Analysis of the basis of the Yemeni economy is complicated by the hidden resources of smuggling, remittances being sent in kind from the Gulf, Saudi Arabia, East Africa and Asia, and the lack of official data on the role of *gat*[xi] in the economy.

The Hadhramaut

Once the Fifth Governorate in the southern state of the PDRY, the Governorate of Hadhramaut stretches from the Rubᶜ al-Khaali desert, over the Eastern Plateau and down to the coast of the Arabian Sea. It consists of two populated areas; Hadhramaut SaaHil - the coastal area with the port of al-Mukalla as the regional capital, and the Wadi Hadhramaut - the inland network of valleys that feed into the main, eponymous Wadi Hadhramaut (see figure 2[31]). In this thesis, I shall refer to the main Wadi Hadhramaut as the Wadi (capital letter) or the Wadi Hadhramaut. The whole network of valleys, including the main Wadi, I shall call the Wadi Hadhramaut network or system. Hadhramaut is the name of the Governorate of Hadhramaut in its entirety.

The three main towns in the Wadi Hadhramaut are Seiyun, Shibam and Tarim. The administrative and trading centre of inland Hadhramaut is the town of Seiyun, 500 km north-east of ʿAden, and 200 km north of al-Mukalla[32] with an elevation of 700m.[33]. Tarim is the religious centre of the governorate and Shibam is the tourist attraction. Each town is primarily residential: there are no densely-packed industrial zones, and no business zones.

[xi] The shrub *gat* (cathula edulis) is central to the social life of the North and much of the South. The leaves are chewed, not swallowed, for a few hours in the afternoon, particularly on the weekend and festive occasions.



Drawn from Desert Locust Survey Reconnaissance Map,

Western Hadhramaut, Sheet C13, Southern Arabia,

(Nairobi, 1952)

Fig. 2. Map of the Wadi Hadhramaut: The area around Seiyun, Shibam and Tarim.

Seiyun is the largest of the three towns, followed by Tarim[34]. The Director-General of the Seiyun *Mudiriyya*[xii], SaaleH ʿAiderous Fudʿuq, estimated that the *Mudiriyya*, an area that includes Shibam, Tarim and all the small towns and villages in-between, consists of about 200,000 people[35]. In 1996, the population of the Hadhramaut was estimated at 718,000 in total, the rural population reaching 479,745[36].

Seiyun huddles around the base of the cliffs at the end of Wadi Jethma (pronounced Yethma), a minor tributary wadi of the main Wadi Hadhramaut. Over the centre of the city towers the massive Sultan's Palace. Two wings of the old city stretch west and south from the palace, keeping to the higher ground. Below the palace, the market and administrative area edges down towards Algeria Street, one of the two trunk roads within the city. The city then fans east towards the other side of Wadi Jethma. Houses across the mouth of wadi are larger and are surrounded by more land than those in the alley-riddled old city. To the north, downstream, is a belt of palm groves called al-Himma, meaning a dense, dark green[37]. Since Unification in 1990, the city of Seiyun has inched up Wadi Jethma and developed new suburbs at the ends and edges of two neighbouring short wadis, ShuHuH and Maryama, creating an E-shaped urban area.

About 15km west of Seiyun is the town of Shibam. Shibam is renowned for its sky-scraper houses constructed with sun-dried mud brick, some of which are 500 years old. The town is bisected by a strip of land 145 m wide containing the watercourse that carries the floodwaters of the main Wadi Hadhramaut, and the road that runs parallel to it[38]. The ancient and famous city of Shibam is on a small square of raised land towards the middle of the Wadi, the newer suburb of SaHiil is under the cliffs, parallel to the watercourse. In the past, SaHiil was the summer resort for the wealthy of the town, and the quarter for the low-income and labouring classes[xiii]. Recently, SaHiil has become a desirable place to build for all members of the community because land is more plentiful than within the old city walls. Outside the old city there are not the same social and building restrictions that force a person to build towards the skies. To the north and east of the old city are neglected palm groves in spate-irrigated basins. Very little trade or administration

[xii] *Mudiriyya*, Local Government district.

[xiii] The wealthy built large villas with lush gardens so that in the summer months they could relax outside the humid confines of the walled city. The exclusion of members of the lower classes from the old city was probably a combination of insufficient finances and prejudice.

is now carried out in Shibam: the nearby town of al-HawTa has become Shibam's market.

Tarim is located about 35km east of Seiyun[39], on the other side of the Wadi Hadhramaut. Tarim is also built under the cliffs and around minor wadis. Like Seiyun and Shibam, Tarim has old quarters of closely-packed houses and newer areas of villas. Also like Shibam and Seiyun, Tarim has experienced a rapid increase in housing, many of which developments have been built in parallel to the minor wadis. There are few shops or administrative buildings. Tarim is famous for once having a mosque for every day of the year. Even today the town is a centre of Islamic learning, attracting scholars from within the Yemen and from abroad.

All three towns are characterised by a predominance of residential buildings, the great majority of which are built with sun-dried mud-brick. This is important for, as will be shown in the next chapter, Shibam, Tarim and Seiyun are subject to flash flooding. The nature of the hazard is important since the inherent vulnerability of mud buildings to flash flooding means that overall vulnerability of these three towns can be assessed through the numbers of houses constructed in an area of extreme susceptibility to floods.

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Chapter 3

Flooding in the Wadi Hadhramaut

The hazard to which the towns of Shibam, Tarim and Seiyun are susceptible is flash flooding. These rapidly rising floods originate in the tributary valleys of the main Wadi Hadhramaut, usually resulting from rainfall on the mountain plateau into which the valleys are incised. Minor floods (spates) are expected annually. However, as these small floods are often the result of convectional rainfall, they are localised, of limited duration and irregular. About three major floods can be anticipated in a century. These are attributed to cyclonic movement over the Arabian Sea and usually occur over much of Yemen, particularly in the south east.

Rainfall

There are two distinct rainy seasons in Yemen: March- April and June- September. Although rainfall is anticipated in both of the seasons, *Hadhaarim* expect more rain to come in the summer months rather than the spring. This is borne out by the records which show that 80% or more of rainfall occurs in July and August, although is rainfall spotty and cannot be guaranteed[ii]. It is considered normal for the Hadhramaut to have 2 or 3 years with no rain[2]. Nonetheless, the absence of rain is accompanied by the expectation that rain will come[3], and with the expectation of rain comes the expectation of flooding. The average annual precipitation in Seiyun is 65.2 mm[4].

Rain can fall as a result of convection or a front brought in by monsoon winds moving east from the Gulf of 'Aden. Convectional rainstorms are the more common of the two types and produce very localised, intense and short rainstorms. Cyclonic rainfall is characterised by severe rainfall over much of Yemen, in particular the south-eastern governorates. Again rainfall is heavy and can fall continuously for over 24 hours[5]. Although little rain falls in the area, the fact that it falls in very intense storms in a very short time is important. The resulting floods have rapid rising times, carry a large amount of water and decline quickly.

[i] See Appendix 2 for local rainfall data.

Rainfall on the mountain plateau (*jol* pl. *jawlaat,* dual *jawlaan*) is generally higher than in the Wadi itself, except for the northern areas of the North *Jol* which can receive less than half of Seiyun's average rainfall[6]. On encountering the mountain plateau, moist air in the summer winds from the south-west is forced to rise and produce rain. The South *Jol* (altitude 900 -1,500m) receives an amount of rainfall only slightly higher than on the south coast[7]. A consultancy undertaken by Interconsult and Mott MacDonald (1993) claims that the "average annual rainfall on the plateaux (Jols) surrounding Wadi Hadhramaut varies from less than 50 mm/ year on the northern jol to over 100 mm/ year on parts of the southern jol"[8].

Convectional rainstorms are generated when a pocket of moist air is warmed by a sun-baked land surface. As the pocket of air rises, it cools and condensation occurs[9]. The build-up of heat during the day necessary to cause these thunderstorms means that the storm usually breaks in the late afternoon and flooding occurs in the early evening. These rainstorms are preceded by particularly hot weather[10]. Seiyun has a mean maximum temperature of 35.5 °C around the year[11]. The hottest month is July with an average maximum temperature of 42.3 °C, and a diurnal temperature range of about 20 °C[12]. Humidity is low in the valley. Throughout the year the mean relative humidity is about 48%[13], but average humidity levels can fall as low as 10- 20% after midday[14]. The pockets of moist air are likely, therefore, to have been carried inland by sea breezes and lifted over the mountains by thermals.

Convectional rainfall is usually very violent and concentrated in an area of a few square kilometres[15]. A full year's average quota of rain for the area can fall in just a few hours (cf. Appendix 2 for monthly rain records), accompanied by thunder and lightning. To illustrate the intensity and brevity of the rainstorms, here are two examples of storms measured over Seiyun. Rainfall from a storm on 23 October, 1977 was measured by an expert from the French consulting firm, SOGREAH, on the roof of his hotel in Seiyun. From 18.15h to 20.50h, 36 mm were measured, 27 mm of which fell from 20.15h to 20.30h[16]. In August 1970, two rainstorms occurred in Seiyun; one lasted 4 minutes, the second one 11 minutes[17].

The major floods of recent history have been attributed to cyclonic influences since storms that are brought in by the monsoonal winds produce very heavy rain over the southern governorates. "In recent years, cyclonic events were recorded in

October 1972, April 1977, and probably March 1982[ii]... . Such events lead to widespread rainfall and extreme flooding in the larger catchments."[18]. "During summer periods of intense convergence of trade winds, complex rainstorms may develop, bringing rainfall to extensive areas"[19]. Tropical cyclones start in the Arabian Sea and carry rain deep inland. Coastal regions and the far east of Yemen and Oman are usually affected[20]. The southern governorates of Yemen are therefore more subject to flash flooding and disruptive weather than the northern governorates. Binnie and Partners (1987) note that most rainfall in the Wadi Hadhramaut occurs at the tail-end of the north-east and south-west monsoons[21]. The north-east monsoon ends in the spring months of March to May. The south-west monsoon ends at the end of the summer in the months of July to September[22]. In the summer, the wind is stronger at about 4.4 km/ hr, coming from the south-west (i.e. from the sea). In the winter months the wind usually comes from the north-east, the Rubʿ al-Khaali desert, at a mean velocity of 1.8 km/hour[23].

Topography

The Wadi Hadhramaut is the most important network of valleys of those that are carved into the Eastern Plateau. The main Wadi Hadhramaut runs from west to east bisecting the Plateau into almost parallel mountain ranges, the North and South *Jawlaan*. The widest point of the network is at the entrance to the Wadi, at the Ramlat as-Sabatayn where the distance between the cliffs is about 20 km[24]. The further east one travels the narrower the Wadi becomes, the cliffs can be as little 2 km apart[25]. At Qasm, the Wadi takes a sharp turn south-east and continues as the Wadi Maseila until it ends at the Arabian Sea. Without including tributaries, the total length of the valley is about 400 km[26].

The North *Jol* has an elevation of between 1500 and 1700 m[27]. Its northern slopes drain gently into the Rubʿ al-Khaali (the Empty Quarter, a desert shared by Saudi Arabia, Oman and Yemen) via wadis that are mainly long, wide and shallow[28]. In contrast, the wadis of the southern slopes are short and narrow with steep gradients. These drain into the Wadi Hadhramaut at an elevation of about 500 m.[29]. They include Wadis Saar, Juʿayma, Thibi and Arda[30].

[ii] The floods of 1996 were probably the result of monsoonal influence.

The South *Jol* is slightly lower with an average elevation of about 1,500 m.[31]. The northern slopes are also steep but have a more gentle slope than the tributaries of the North *Jol*. They also tend to be longer, Wadi ʿIdm is about 100 km long. The main wadis are: Wadis ʿAmd, Duʿaan, al-ʿAin and ʿIdm[32]. Slopes on the southern side of the South *Jol* drain into the sea at a moderate gradient.

Flooding

As the Wadi Hadhramaut is an arid inland area, the majority of the wadis in the Wadi Hadhramaut are dry for most of the year. When it does rain, the two crests of the North and South *Jol*s are the most important watersheds in the catchment area of the Wadi Hadhramaut. The floods that affect the Wadi Hadhramaut come from tributary valleys that start in the north and south *Jol*s, bringing runoff from a catchment area of approximately 34,000 km^2 [33]. Precipitation is estimated at 2040 mcm p/a with a runoff of about 500 mcm[34iii].

A distinctive feature of the valleys of the Wadi Hadhramaut network are the flat-topped cliffs that rise almost vertically from the level wadi bottoms. In the main Wadi these limestone cliffs are between 200 and 300 m high[35]. When it rains on the *Jol*, the water cascades off *shuHura* (pl. *shuHraat*), dry waterfalls slightly below the level of the cliff face, and from the heads of the tributary wadis (*ruus*)[36]. As the cliff face has a clearly-defined layer of rocks at the top that falls away in a steep, scree slope to the wadi bottom, runoff is rapid. At the base of the cliff, streams are formed. These converge in the main watercourse and the dry watercourse swiftly fills with water. The water rises to form a turbulent and fast-flowing "wall" of water that can have a rising time of less than 30 minutes[37iv].

Runoff is rapid in the tributaries of the Wadi Hadhramaut because slopes are steep, the surface is either bare or covered in scree, and there is minimal vegetation[38]. On the wadi bed, the watercourse is less steep but still barren, for the flood takes a similar path each time, prohibiting plant growth. Only between Buur and Tarim is the watercourse being encroached by prosopis trees (*siisibaan*). Vegetation on the flood plain is sparse, some calligonum, sea sedge and camel thorn[39]. On wind-blown

[iii] Another assessment of the catchment area of the Wadi Hadhramaut defines the catchment as the "plain country of Hadhramaut bounded by north and south watersheds and the plateau of the Ramlat as-Sabatayn.", with an area of 114,325 sq. km and a total annual precipitation (without evaporation or transpiration) of 1,300 mcm (Dar al-Handasah Engineers and Architects (Shair and Partners), 1972).
[iv] In Wadi Yeshbum (Shabwa), floods rise in 20 minutes (Atheer SalaaH ad-Diin Najm, 19/2/97).

sand there are shrubs: *racca* (salvadore persica), *ʿelb* (zizyphus spina Christi), and *ithl* (tamarisk)[40]. Preliminary rainfall can "seal" the soil surface so that infiltration rates are reduced and runoff increases.

The flood waters continue to rise until peak flow is reached[41]. Once the peak has been reached water levels drop fairly rapidly, until there are only a few puddles left in the wadi bed[42], although floods in the Wadi Hadhramaut main channel can last up to five days. The hydrograph in figure 3[43] shows the flow record of two flash floods in Wadi Surdud, a large valley in the Western Massif that flows towards the Red Sea[v]. Starting from a insignificant base flow, it illustrates the rapidity with and extent to which the flood rises. There are two peaks on the hydrograph showing that there were two floods after successive rainstorms. When the waters subside, the wadi bed is left covered in sediment and rocks, scoured from the mountainside and the edges of the wadi by the fast moving floodwaters.

Where a tributary valley joins the main Wadi Hadhramaut, the valley reaches the plain, the watercourse and the flood widen and become more shallow. Since flash floods vary in size; not all of them reach the plain dispersal area. A valley may have as many as 50 floods in a year[44], but these are more in the realm of spates than full-scale flash floods. There is a cusp, a small watershed that divides the water that ponds at a place called Khashaʿa, at the convergence of Wadis al-ʿAin, Duʿaan, and ʿAmd. At this point the water flows either into the Ramlat as-Sabatayn or into the main watercourse that heads east to Seiyun[45]. The majority of runoff flows seaward, gradually being absorbed into the Wadi bed[46]. Most of the Wadi and its tributaries are covered by a "coarse-textured highly permeable top soil"[47]. Stream flow filters into the sandy soil of the wide bed of the Wadi Hadhramaut and irrigation networks[48] to the extent that about 67% of total floods in the irrigation channels are lost by filtration[49].

The higher levels of rainfall on the *jol* has implications on the flooding patterns of the Wadi. Relief rainfall can lead to more major floods than convectional rainfall. Table 1 gives some comparison of the quantities of runoff from tributaries from the North and South *Jols*. It can be seen that the northern tributaries receive less rain than those of the south, with correspondingly lower levels of runoff. The tributary wadis of the South *Jol* are generally longer and have larger catchment areas than

[v] I was unable to find a hydrograph of any valley in the Wadi Hadhramaut.

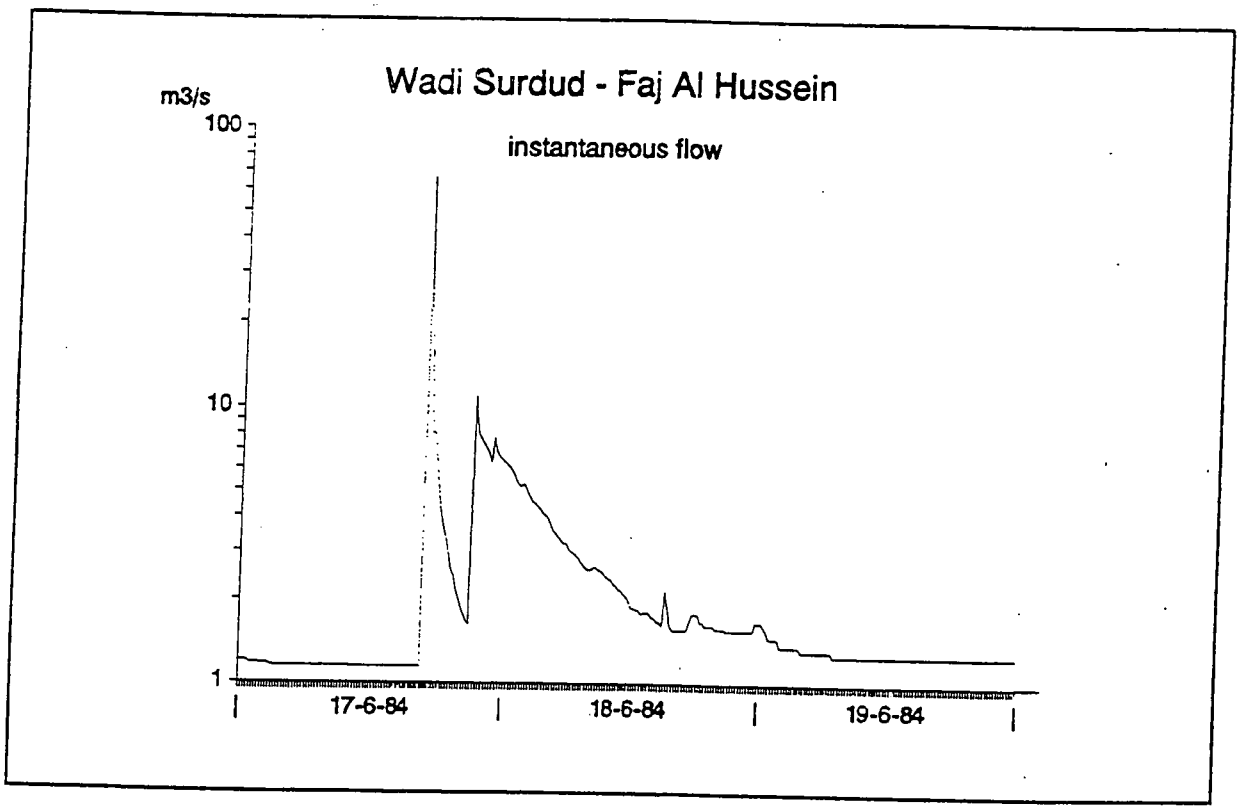

Fig. 3. Flood Hydrograph, Wadi Surdud.

those of the northern *jol* and flood more regularly. The most regularly flooding wadi of the Hadhramaut network is Wadi ʿIdm which carries a flood flow almost every year. Fortunately it seriously threatens no town for it joins the main channel just below Tarim[50]. The southern Wadis, ʿAmd and Duʿaan, that run from the southern *jol* also carry large amounts of runoff, supporting the fact that greater amounts of rain falls on the southern wadis. Wadi Saar, in the north-west, is the exception of the northern wadis for it also floods quite frequently.

Wadi	area (km2)	mean annual precipitation (mm/ yr.)	mean annual runoff (mm/ yr.)
from South *Jol*:			
ʿAmd Duʿaan	6550	80	20
al-ʿAin	1500	75	10
ʿIdm	5485	70	41
Bin ʿAli	720	65	4
from North *Jol*:			
Sarr	2540	45	3
Juʿayma	760	35	1
Thibi	720	40	2
Minor Hadhramaut tributaries	3800	45	

Table 1: Estimates of mean annual runoff[51]

Most of the floods that make the main channel of the Wadi come from the large wadis like Saar, ʿIdm, Duʿaan, and ʿAmd[52]. Long tributaries like Saar and ʿIdm can carry floods for two or three days[53]. In a convergence area like MaHdooda, a village between Shibam and Seiyun but on the other side of the valley, the flood can flow for five to six days, especially if it floods in Wadis Saar and Juʿayma at the similar times[54]. Small tributary wadis like ShuHuH, Jethma and Maryama carry floods for about an hour to 1 ¼ hours[55]. Apparently, if it rains on the *Jol* above Maryama continuously from, for example 18:00hr to 21:00hr, then the water in the Maryama

watercourse will be three to four metres deep[56]. During the floods in the June rainy season of 1996, it rained over the village of al-Ardh (near Seiyun) for about half an hour but water continued to pour off the mountain for six hours[57].

Each town is affected by different tributary wadis.

Shibam gets floods of all sizes every year[58] for it is subject to the runoff from at least four tributary wadis, Wadi Saar and the collected waters of Du'aan, 'Amd and 'Ain[59]. Wadi Saar is particularly dangerous as it floods irregularly and copiously[60].

The combined flood waters of the main channel of the Wadi Hadhramaut run to the north of Seiyun without affecting the town. Seiyun is built on the edges and across the alluvial fan of the rarely-flooding Wadi Jethma. The village of Maryama, which has become a suburb of Seiyun, is built at the end of a short wadi, as is the new suburb of ShuHuH.

Tarim also escapes the force of the combined flood waters of the main channel as the channel curves around the outskirts of the town, cutting through agricultural land. The minor wadis that flow through and around Tarim are Wadis 'Aidiid, Thibi, Gataba, Khaila, Na'ir, Shu'ab Haadi and Dumoon, the last four winding their way through the town centre[61]. Wadi 'Aidiid has the potential to carry large quantities of water, but does so infrequently and so is not considered dangerous[62].

Flooding in the Hadhramaut frequently happens in series. In 1989, it rained heavily from evening to dawn over Tarim, Wadis 'Aidiid and Thibi both flooded. Three of four floods came in series. The first storm lasted for one and a half hours, after which Wadi Thibi flooded[63]. In 1996, there were three flood bursts on three successive days on Shibam, all from Wadi Saar. The largest flood came on the second day[64]. The rainstorms of August 1970 given above, resulted in a flood with a discharge rate of 2513 m^3/s[65].

Flood Summary

The Wadi Hadhramaut has a very short history of meteorological data collection. Various political, social and economic factors have prevented a comprehensive collection of data in the valleys of the Wadi Hadhramaut. Before the 1930s, the Wadi Hadhramaut was continually disrupted by tribal disputes. Even after treaties were signed between the tribes and the British colonists, the area still received little scientific attention from British or local investors. Climatic data for the Wadi Hadhramaut begins in the 1970s. A meteorological station was established at Seiyun Airport and its rainfall records begin in 1980. However, organisation of these data is still rather chaotic, they are hand-written and hand-compiled. In response to my requset for rainfall data (May 1997), employees copied out the compiled records from 1990 to 1994 by hand. Data from 1995 to 1997 (including the rainfall results of the June 1996 period of flash flooding) had yet to be collated. The project centre of the Wadi Hadhramaut Agricultural Project[vi] in Seiyun has also kept records since 1977. Between 1979 and 1981, eleven rainfall stations were set up by the Russian team Selkhozpromexport for short lengths of time[66]. Other teams of consultants include SOGREAH in 1979 and 1982, WHAP regularly, Binnie and Partners in 1987, and Interconsult and Mott MacDonald in 1988 and 1993. Technical studies with the aim of protecting Shibam from flooding were carried out by UNESCO in 1982 and 1983[vii].

The accuracy of the available data can be called into question. As the nature of convectional rainstorms is to drop rain in very localised areas, the gauge network can miss out on a rain event. This is especially the case since rainfall gauges are usually situated near towns so that data can be easily collected and equipment maintained[viii]. Rainfall, of course, does not only occur over and near towns. Most settlement is in the valley rather than on the *Jol* where the majority of the rain falls. Van der Gun and Ahmed (1995) comment that data on flow volumes are "...of variable reliability and accuracy. The wadis offer extremely difficult conditions for stream gauging. The wide natural wadi beds generally lead to insensitive rating curves that suffer from frequently shifting controls. Current metering is rarely

[vi] The Wadi Hadhramaut Agricultural Project (WHAP) is a government agency, sponsored by the IDA (World Bank) and other funding agencies, including the Arab Fund. It is located 155 km inland (Binnie and Partners, 1987: table 1.3.1)

[vii] For example, Lewcock, (1986)

[viii] Climatic data collected by the Seiyun Agriculture station at a longitude 48°- 40°east, latitude 15°- 17° north, and an elevation 570 m above sea level (El-Tash and Ismail, 1987: 8). It is located 160 km inland (Binnie and Partners, 1987: table 1.3.1).

done at intermediate flow rates and never at high rates, because it is difficult to be present at the time that floods occur, the floods tend to occur during darkness, and there are usually no provisions - such as bridge or cable-way - for carrying out the measurements at high water levels. ... Furthermore, the floods are often destructive or may disturb the operation of the installed equipment".[67].

In the absence of comprehensive scientific data, I have collated a list of floods and estimates of their size from reports, papers and oral accounts (Table 2). Flood accounts before 1950 are taken from a paper by ʿAli ʿAgiil on irrigation in the Wadi Hadhramaut that lists some major floods that struck the Wadi Hadhramaut. He compiled the list from various local and western sources. Other accounts of ancient floods are taken from Interconsult and Mott MacDonald's 1993 report on flooding in the Shibam area. The consultants cite eight floods that a local historian, ʿAbd al-Gaadr aS-Sabbaan, had collected from historical literature. Of course, it is possible that flood event dates have been recorded incorrectly or lost in the process of transmission. Certainly, accuracy has been lost in converting dates recorded according to the Islamic calendar to the Gregorian calendar. There is a margin of error of one year on either side of the date[68]. The report by Interconsult and Mott MacDonald questions the accuracy of dates given to the floods[69]. Their reasoning is based on the fact that four of the floods took place in the 98th Islamic year of the respective centuries (698 AH = 1298, 898 AH = 1493 AD, 998 AH = 1590 AD, 1098 AH = 1687 AD). However, once the dates are converted into the Gregorian calendar, the coincidence is lost. Nevertheless, there are benefits in the analysis of recorded floods. From the list one can work out an estimated return period for the floods, which wadis flood the most regularly, and the towns that were affected.

As oral accounts depend on the memories of living people, the flood histories given by local residents are restricted to larger floods in the latter half of this century. People rarely remember flood events other than those that were extraordinary in scale, duration and impact. This is useful for it acts as a filtering system, only major floods are caught in the net of memory. The key floods in this century, as reported by *Hadhaarim*, are 1955, 1982 and 1989, although not all floods that are remembered in Shibam are remembered in Seiyun (and vice versa). The effects of the floods depend on the localised nature of the rainstorms, and the route the main channel takes. The records from the 1970s, and conversations with *Hadhaarim* show that flooding in the Wadi Hadhramaut is a routine occurrence. These factors

draw to our attention the fact that a large flood does not automatically result in a disaster that affects the whole region.

Year	Period of time since last recorded flood	Southern Wadis affected	Northern Wadis affected	Towns affected	Damage	Source
1225		ʿAmd, Duʿaan, al-ʿAin, Haynin		Shibam, Tarim	Trees uprooted, many people drowned	[70]
1249	24	implied[ix]		damage to Shibam	400 people drowned	[71]
1298	49	implied		most of Shibam destroyed	Fields spoiled	[72]
1323	25	Duʿaan			Palms and trees uprooted	[73]
1356	33	implied		some damage to property in Shibam	14 killed	[74]
1391	35		Saar, al-Huun, Thibi		lots of property and palms lost	[75]
1409	18		Juʿayma	Shibam, but floods were *widespread*		[76]
1446	37		Thibi		washed away weir network	[77]
1486	40	all	Hadhramaut		Palms and threshing floors destroyed, also weirs	[78]
1488-9	2	ʿAmd, ʿAin, Duʿaan, ʿIdm	Saar, Thibi			[79]
1493	47	ʿAmd, Duʿaan	Saar, Thibi		lots of people and livestock drowned. Palms and houses destroyed	[80]

[ix] If Shibam is affected then Duʿaan and its sisters are implicated in the flooding

1495	2 (same flood as 1493? According to Serjeant, there were many floods at this time)	implied		Shibam		[81]
1532	37	Du'aan		destroyed much of Shibam, but not as much as 1298	destroyed 4,000 palm trees, fields and eroded topsoil	[82]
1562	30	widespread	flooding. It rained for some 48 hours	Shibam	many houses destroyed and palms lost. People drowned from Tarim	[83]
1582	20				170 people drowned, palms lost	Mott
1590	8	'Idm			uprooted palms	[84]
1687	97	implied		Shibam	a mosque and agricultural land destroyed	[85]
1717 two flood -s	30 Serjeant gives the date for this flood as 1712-3	'Idm		Shibam, Tarim: in the second flood, ten mosques that had been built on the banks of the watercourse were destroyed, as were some houses	uprooted many palms, scoured lots of topsoil. drowned a large number of people and livestock. 2nd flood: palms uprooted, the town of al-Ghuraf was damaged, as was a village in the region of 'Ainaat	[86]

	No records of floods between these dates					
1914/ 1913	197/ 196	ʿAmd, Duʿaan, Rakhia, ʿIrma, al-ʿAin	Sarr		The entire Bin Ramaidaan family washed away during a wedding party. This is called the Bin Ramaidaan Flood. Serjeant believes that the tragedy occurred in a different flood	[87]
1948/ 1949	34/ 36	implied		Shibam		[88]
1954	7	Duʿaan		Shibam Tarim	thousands of palms lost and many fields and irrigation networks destroyed	[89]
1954/ 1955	same year as the 1954 flood in Duʿaan	Jethma		Seiyun: houses destroyed and damaged		[90]
1974	20	implied		Shibam		[91]
1977	3	Duʿaan, ʿAmd. Bin ʿAli, al-ʿAin High rainfall on South Jol	Saar: small flood			[92]
1978	1	implied	Saar, Thibi	Shibam		[93]
1981	3	Duʿaan, ʿAmd, ʿIdm				[94]
1982	1	Jethma, implied		Seiyun, Shibam: properties destroyed and damaged	agricultural sector badly stricken	[95]

1984	2	implied	Thibi	Tarim, road blocked channel. Shibam: poorly designed bridge caused floods to back wash	irrigation channels in Shibam damaged	[96]
1986	2	implied		Shibam		[97]
1987		implied		Shibam		[98]
1989		implied	Ju'ayma, Saar,	Shibam, Seiyun and Tarim; four houses destroyed in Tarim	one child drowned, agricultural sector hit	[99]
1992	3	implied		Shibam		[100]
1996	4	yes	yes	Shibam, Tarim, Seiyun: six houses destroyed in Shibam, about 20 damaged	utilities rendered inoperable, palms and fields destroyed, diversion weirs and irrigation structures in Shibam damaged	[101]
1997	1		'Aidiid, Gataba	Tarim	houses threatened, two weirs destroyed	[102]

Table 2: Flood Summary, 1225- 1997

The list shows a pattern of major floods occurring in the twenties, fifties and nineties of each century, giving an approximate return period of about thirty years[x]. The pattern breaks down in the 17th, 18th and 19th centuries as I have been able to trace only two records of major floods for that period[xi]. A marked increase in recorded flood events since the 1970s is evident in the list. This does not mean, of

[x] SOGREAH estimates that a discharge of 850m^3/s at Shibam represents a 20 year return period (Interconsult of Norway and Mott MacDonald of UK. Discipline Reports, (1993).

[xi] Were there no records or no floods? Lewcock (1986) mentions that in the middle of the 19th century, there was considerable migration from the valleys of the Wadi Hadhramaut network to the Far East and East Africa as the area was riven with tribal disputes. It could be that the intertribal conflict and migration had their roots in climatic conditions such as drought.

course, that there have been more floods. There now exist the facilities to record even insignificant floods, and more people are alive to recall them. Following the 1954 floods in Du'aan, the British government posted guards at remaining forest areas for it was proposed that deforestation had been a factor in the severity of the flooding. The continuing reduction of vegetation in the region could well be involved in the increased frequency of flood events.

As expected, floods originating from the southern *jol* are shown by the table to be far more frequent than flooding from the northern *jol*. Since the danger for the towns in the Wadi Hadhramaut comes when it rains in the mountains of more than one tributary valley, it is probable that the floods which have had more disastrous effects on the Wadi are those whose origins are cyclonic rather than convectional. The spottiness of convectional rainfall in the area means that not all the wadis flood at one time, many years could pass between floods in any one valley.

Most records of flooding in the Wadi Hadhramaut report on the damage to the agricultural sector rather than to the towns in the area. The main reason for the greater vulnerability of the agricultural sector to flash flooding is the need for water, and the consequent encroachment of agricultural lands into the wadi beds. The well-being of the agricultural sector was vital to the survival of the communities, the majority of whom depended on their fields for their own food and for their income. In the past, one could not look at the towns in isolation from the land which people farmed. A disaster in the agricultural sector was a disaster in the towns since the failure of crops and the loss of palm trees affected trade and survival. Even today, the agricultural sector is still the largest employer in the country, and the social and economic implications of severe and widespread damage to the sector are enormous. However, with the greater availability of employment opportunities and imported goods, it is now more feasible to look at the towns in isolation as fewer residents are now actively involved in agriculture.

Of the three towns under consideration, the list shows that Shibam has borne the brunt of the majority of the great floods in history. If Shibam is affected then Wadis Du'aan, 'Amd and al-'Ain are implicated in the flooding. The prospect of a flood issuing from these valleys or any combination of them, means that Shibam's location on the banks of the main channel of the Wadi Hadhramaut is considerably more hazardous than the locations of the other two towns. This perceived threat

has been the subject of many consultancies aiming to protect Shibam, a World Heritage site since 1982[103].

As Tarim is situated on the northern side of the Wadi, the tributary wadis which discharge through it are less likely to carry large floods as they have smaller catchment areas and receive less rain. Nevertheless, since it is built around the channels of seven minor tributary wadis, the town is likely to suffer frequently from small floods as a result of convectional rainfall.

Although Seiyun is located on the southern side of the Wadi, the list shows that it has only suffered three major floods. This is because the wadi in which the town is now built has a very small catchment area, therefore collecting less rain and discharging fewer floods. It is interesting to note that recorded damage inflicted on the town has only occurred in the last century, perhaps showing an increased vulnerability to the floods.

In conclusion, the Wadi Hadhramaut is subject to frequent floods of varying scale and intensity. If the area receives rainfall, it usually does so in two seasons of the year, late spring and summer. Floods are expected since they are the likely outcome of each rainstorm. Although they are expected, they cannot be predicted for rainfall is spotty and irregular, and the floods can rise so rapidly that they preclude warning. For major floods there seems to be an approximate return period of 30 years. The occasion of a flood does not automatically result in a major disaster; some floods are too small to pose any threat. Instead, they benefit the crops that rely on spate irrigation. Of the three towns, Shibam is the most vulnerable to the effects of larger floods because of its site just below the convergence of the watercourses of four tributary wadis. Tarim is subject to small floods that fill the small channels that thread through the town, Seiyun is only recently becoming vulnerable. Since it is the vulnerability of the towns is the isssue under discussion, and since the towns are largely residential, the construction methods and integral aspects of the houses that mitigate against flash flooding are described and analysed in the following chapter.

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Chapter 4

The Hadhrami *House*

In urban Wadi Hadhramaut, the house is the family's most important possession[1]. Not only does the importance of the house reflect, by housing the extended family, the value attached by Yemenis to communication across the generations[2], it also reflects the increase in urbanisation. The three towns under discussion are currently primarily residential. Fewer people own land and, in the process of urbanisation, land has become more valuable for construction purposes than for the crop grown on that land[3]. Although the house is often a man's most valuable possession, and the biggest investment he will make in his life, it is potentially one of the most vulnerable items to rainfall and flash-flooding that he owns. The main reason for the likely damage of a house by flooding is the lack of resistance of the construction material (mud) to fast-moving flood waters. However, the tradition of building houses with sun-dried mud-bricks has been maintained for over a thousand years, despite the hazard of flooding. It is therefore necessary to examine methods of construction that mitigate against the effects of flash flooding.

Since most of the houses in the area are made of sun-dried mud-brick, the number of houses damaged or destroyed by a flood is a good measure of the level of vulnerability to flooding. Although it is often the case that social groups have differing levels of vulnerability, this is not the case in the Wadi Hadhramaut because methods of construction are similar in all strata of society. If a house is situated in a safe area, constructed well and properly maintained, then it can be inhabited for hundreds of years. Inhabitants are very aware of the risk that rainfall and floods pose to the house for mud houses require assiduous maintenance. In the event of rain, minor repair work is expected. Since living standards directly affect the strength and longevity of the house, the links between vulnerability and daily life are very important. If the houses do fall down then it provides a comment on the social structures that caused them to be built in the susceptible area in the first place, for example poverty, land shortage and migration patterns.

In the aftermath of a flood, one of the priorities of the victims is the construction of shelter. In this respect too is the loss of a house a leveller. Rarely is external aid

donated for the reconstruction of houses. Large tents are sometimes provided but are rarely large enough for the whole family. Homeless families would rather stay with members of the extended family whose houses were left undamaged than split up their close family[4]. Social problems are highlighted by the flood as divisions between the vulnerable and not so vulnerable, the rich and the poor, can also be exacerbated by a disaster. A family that has migrated from outlying areas without the extended family, or whose extended family lacks the financial facility to support the homeless members, is more vulnerable than a family with strong community ties and financial backing. The problems of migration and poverty might not have been immediately obvious before the onset of the flood event. The destruction of a home is a devastating loss for a family. Not only can the cost of replacing the house be crippling, the length of time necessary for the reconstruction of the house means that time that could be used for earning money is lost. Again, the relative vulnerability of a group of people is emphasised by the speed in which houses are reconstructed and rebuilt. A rich family can usually afford to rebuild their house more quickly after a flood than a poor family.

Construction Methods

The traditional and predominant construction material in the Wadi Hadhramaut and its tributary valleys is the sun-dried mud-brick (*madra* - pl. m*adar* "sun-dried mud-brick"). No-one builds a house completely in stone, except far up remote valleys and on the plateau[5]. The mud-brick regulates the temperature in the house by retaining and radiating heat in the cool nights and absorbing the heat during the day so that the rooms remain cool. These insulating properties continue to make it an attractive material for house construction. Nevertheless, for an area that is subject to flash floods, the construction of mud-brick houses seems rather imprudent. Mud-brick puts up very little resistance to flood waters, particularly when large amounts of debris are carried in the water. Hard debris increases the speed of erosion and thereby the subsequent collapse of the house. However, the argument is not as simple as first it might seem. Certain properties of the mud-brick itself, methods of construction and maintenance combined with careful town-planning, have enabled houses to stand for centuries unharmed and, in falling, threaten no-one.

Sun-dried mud-bricks

Madar are made from three basic ingredients: mud, chaff or chopped straw, and water, moulded into rectangular mud pies and left to dry in the intense sun. Traditionally, the mud (*Tiin*) for *madar* comes from around the roots of palm trees[6] where agricultural processes, including spate irrigation, have increased the amount of clay and humus in the soil, both of which make a stronger brick[7]. Good quality (*zubr*) mud contains about 10% clay[8i]. Today, mud is still taken from agricultural fields. *Madar* workers in Seiyun[9] are using mud from fields surrounding the three nearby villages of Buur, Tariis and Taaraba.

A large pile of mud is left for a day to ferment with a hose-pipe dribbling water into a slight depression in the top. The following day, the materials are mixed together by one worker working with a short handled hoe. Handfuls of chopped straw (*tibl*) are scattered over the top of the mud pile. The mud worker (they have no specific names for this is group work) uses a short-handled hoe to mix the fermented mud, *tibl* and water into a sloppy mess at his feet. He works quickly, taking short, straight strokes. The rough proportions of *tibl* to mud are known to the master *madar* maker. The proportions depend on the quality of mud being used, *zubr* mud needs more *tibl* that *sibakh*[ii], but the quantity of the *tibl* is referred to as "*zay sukr fi shaahy*", like sugar in tea[10iii].

As he works, two other men take wheelbarrows of the wet mix from around his feet to dump near the brick makers a few feet away. Three men work with wooden frames shaped like open books (*mithal* or *miftal*). One of the men takes large armfuls of the mud mix and deposits them into rows, roughly working them into rectangles. He is followed by the men with frames who smear the patties into the corner of the frames, lift up the frames, then progress to the next pair of patties. The *madar* are made slightly thicker in the middle of the rectangle. The *madar* have to be left to dry flat for 5/ 6 days in the winter and 3/ 4 days in the summer.

[i] A breakdown of the components in the mud is shown in the table below. (Blanc, 1990)

Component	percentage
Alumina	24
Silicon	50
lime and magnesium	6
ferrous oxide	8
organic matter	2

[ii] Saline, poorer quality with less binding power.

[iii] *Hadhrami* tea is extremely strong and red, drunk in tiny glasses with at least two spoonsful of sugar at the bottom.

The *madar* continue to dry on their edges, arranged on the ground like an ear of wheat, a pattern called *Hamiir*[11]. They are left in the *Hamiir* position for 10 days or a week, after which they are stacked in piles. The longer they are left to dry, the stronger the *madar* will be[12].

The foundations

Before the mud bricks are laid, a trench is dug and stone foundations are laid in order to give solid support to the heavy walls, tie the walls to the ground and provide a defence against creeping ground water and floods. Stone foundations are used when the house is being built close to the cliff edges and in mountainous areas to avoid the settlement that occurs when different types of building material are laid upon each other. The stone foundations "tie" the house to the stony ground onto which it has been built and prevent slipping. According to one source, new houses being built in Tarim do not always need stone foundations[13], nor do houses that are built in agricultural land, for the *madar* is made of the same material as the ground and binds well to it.

Traditional foundations in the old city of Shibam fill a trench that is one and a half times to twice the width of the intended wall at ground level[14]. The wall is usually about 86 cm wide, depending on the builder, therefore the trench measures between 129 -172 cm. The trench is dug until hard ground is reached, at a depth of about 160 cm[15]. Three *adhruᶜ* of stones are then laid[16]. The measuring unit *dhiraᶜ* - pl. *adhruᶜ* is approximately 45 cm[17]. Logs, lime, salt and animal dung are also used in the traditional *Shibaami* foundation, on top of which is laid rubble and five to six layers of tight-fitting stones. The stones are laid until the foundations reach 3 *adhruᶜ* above ground level[18].

Outside of Shibam, foundations of one *dhiraᶜ* above ground level suffice[19]. In the new suburb of Shibam underneath the cliffs, SaHiil, foundations only have to be dug to a depth of one or two *dhiraᶜ*. Foundations in Seiyun are today made of stone bound together with cement and plastered with *nuura* (for an explanation of *nuura*, see below). AHmed Jerboaᶜ, a *muᶜallim saas* (foundation specialist), said that the foundations he makes usually extend half a meter underground and one meter above[20]. The stones are carefully fitted and bound together by cement (see plate 1).

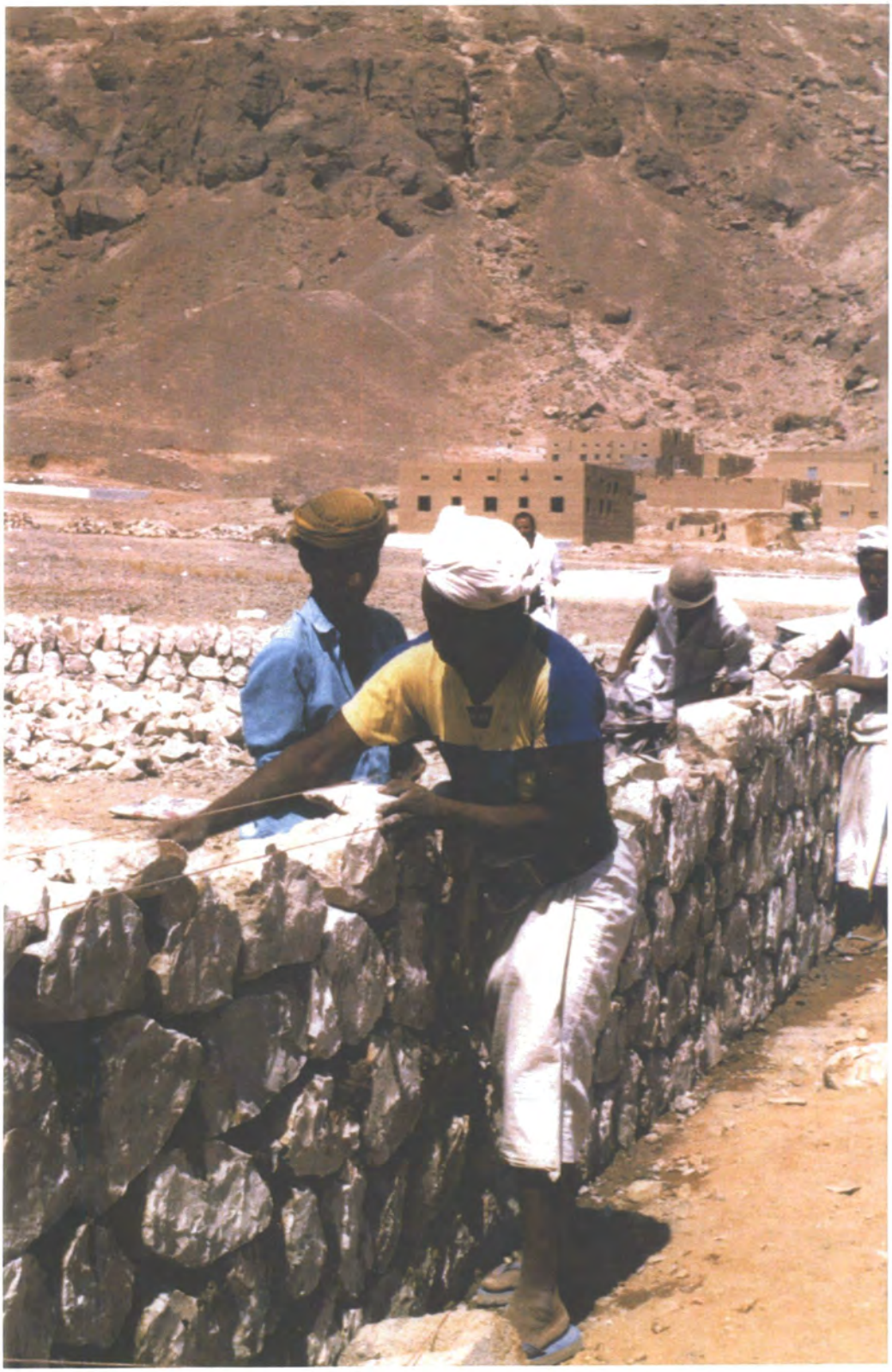

Plate 1. Making foundations for a house on the outskirts of Seiyun

Foundations for a house 18' by 15', at a height of one meter above ground, cost 120,000 yr. inclusive. About sixty tons of stones are required, each lorry-load of 5 ton costing 10,000 yr.[21].

The square formed by the foundation walls is filled with "mountain mud" to create the *kabs*[22], the base upon which the walls of the house are built. Apparently "mountain mud" is a type of clay, used to make pots and the terracotta drum of the bread oven. It is also used for filling up the spaces between *madar* in walls and the stones in the foundations[23], and is a material used in making flood defences[24].

Foundations in the older quarters of Seiyun and in Shibam SaHiil are protected by a large step made of stones, cement and *ramaad*, this is the *dikka* pl. *dikuk* shown in figure 4. *Dikuk* are constructed around the base of mud houses, hard against the base of the outer walls[25]. The *dikka* can be built around only the door or can stretch around the base of the house[26]. Constructed around the lower level of the tower houses in the old town of Shibam is a sloped lime plaster dado.

The walls

Wall thickness varies from house to house, depending on the builder[27]. Table 3 gives approximate wall thickness for a house in the old town of Shibam. As larger and stronger *madar* are needed for the layer on top of the stone foundations than towards the top layer of the house, the walls are built so that the outside wall slopes in and the inside walls remain vertical[28]. The batter is not noticed inside the house (see figure 5). Lighter and thinner bricks are needed for inner walls and ceilings[29].

ground floor	86 cm
2nd floor	69 cm
3rd	57 cm
4th	46 cm
5th	34.5 cm
6th	28.5 cm
7th	23 cm

Table 3: Width of walls by storey[30]

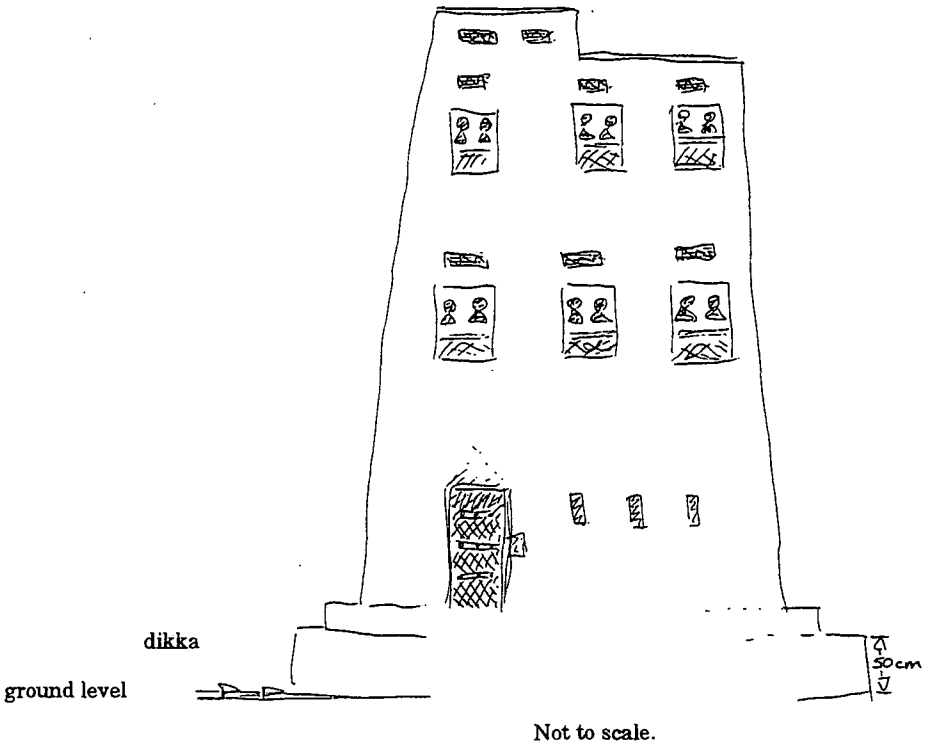

Fig. 4. Sketch of a *Seiyuuni* house with *dikka*.

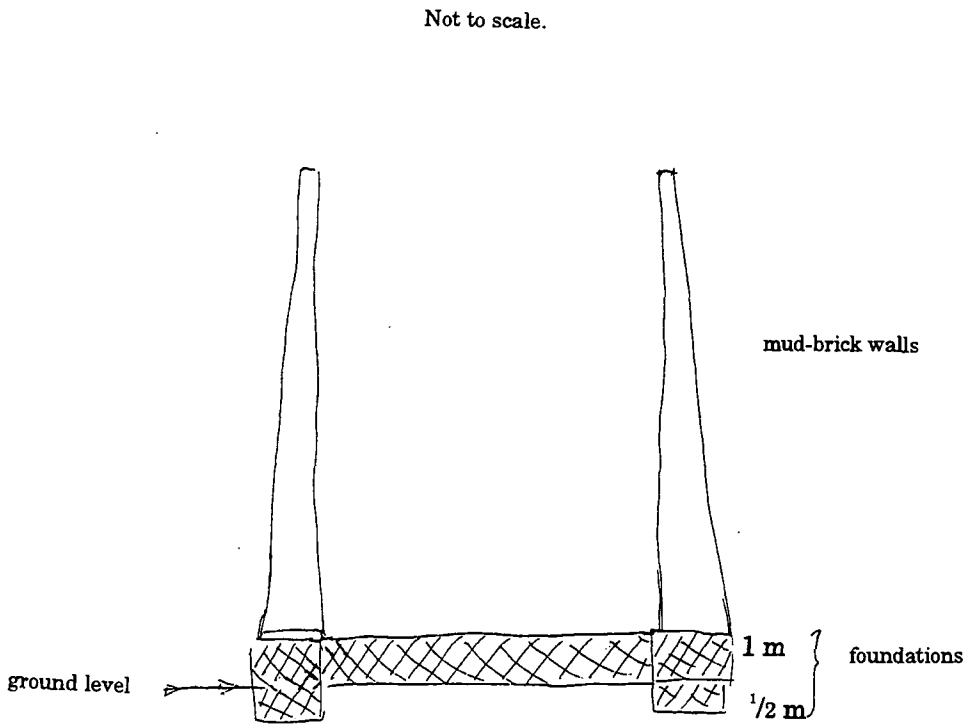

Fig. 5. Sketch of house walls and foundations showing the sloped outer walls and the straight inner walls.

On top of the foundations are laid the *madar*, bound together with *mulaT* or *gharaq*, a paste made of the same mud and *tibl* as *madar*. There are four methods of laying *madar*; (see figure 6)

1. *maʿaroudha*: this is the most basic method and involves laying the *madar* in regular lines, with the narrowest edge on the outer and inner sides of the wall and the wide edges adjoining the next *madra*[31]. This method is used for the first floor outer walls and above[32], and the interior walls.
2. *sabayatayn*: this is a stronger method than *maʿaroudha*. The *madar* are laid with the widest edges on the outside of the wall, i.e. are laid in the opposite direction to the *maʿaroudha* method.
3. *sabia wa maʿaroudha*: this is the strongest method as it is a combination of the two methods described above. On the level, three *madra* are laid horizontally (*maʿaroudha*), next to them are two laid vertically (*sabayatayn*). This latter method is used for the levels above the foundations, and the *ʿarus*, the central, supporting pillar of the house around which is wrapped the staircase. S S. Damluji mentions that this method is also used for the construction of the *khunuun*[33], the ground floor rooms used for storage.
4. *ʿagf*: another strong method, this technique of laying madar is used for the first layer above the foundations and for expensive ceilings. The bricks are stacked vertically, like books on a shelf. It is a very costly method because it uses so many bricks[34].

Walls are constructed *gaama* by *gaama*, each *gaama* being a layer of bricks laid to the height of a man. Once a *gaama* is completed then the house is left to dry for a few days before the next *gaama* is laid. Gradually the house grows in height. A house in the old town of Shibam can be eight stories tall, in Tarim, Seiyun and Shibam SaHiil the houses are usually about four storeys high. The outside of the walls is finished with a *zubr* mud and chaff plaster called *taliiS*. This plaster resists rain and is the undercoat for the important layers of lime plaster. For poorer households this mud plaster is the final coat on the house.

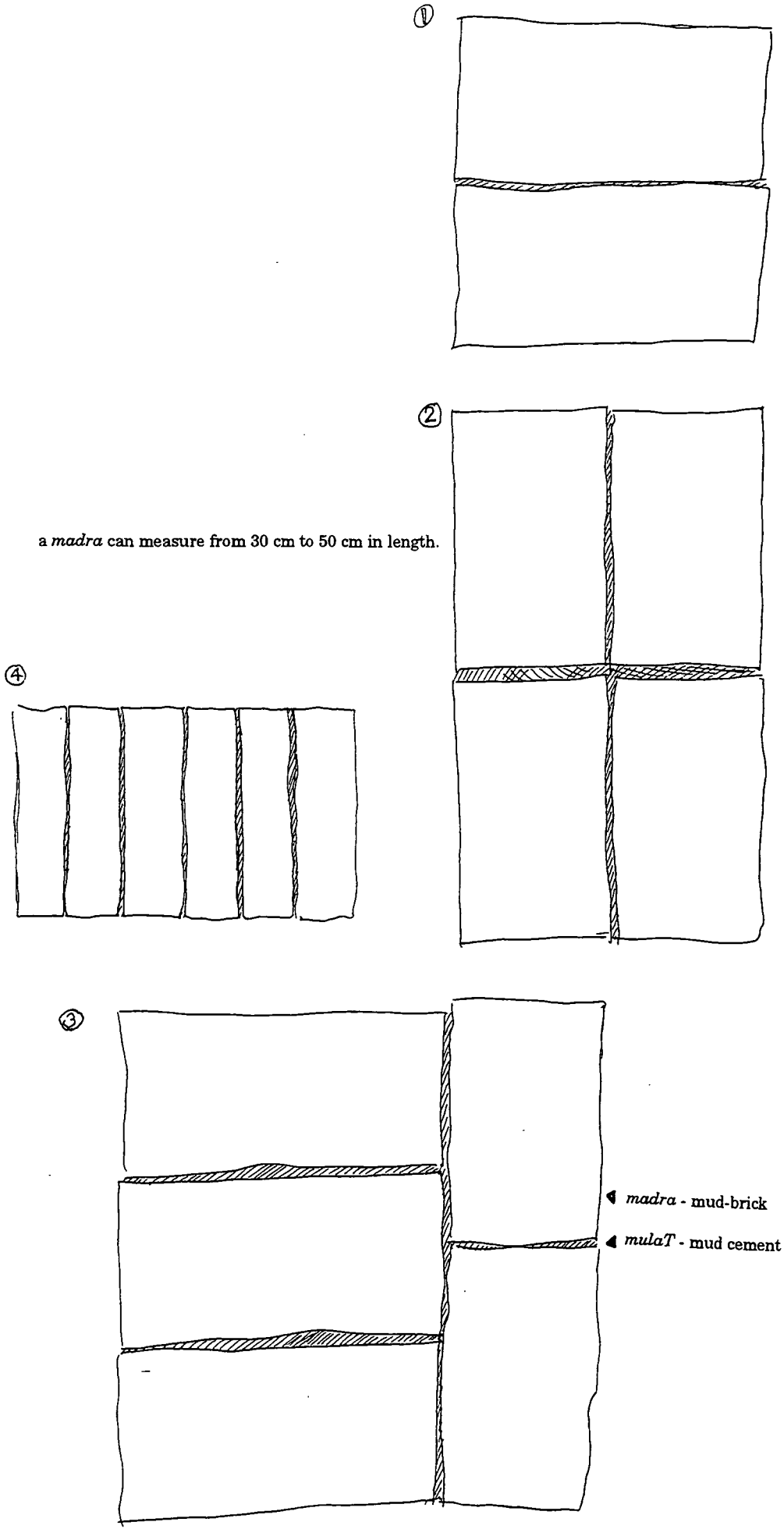

Fig. 6. Methods of laying *madar*.

Nuura: *Lime plaster*

Nuura is the generic word used in the Hadhramaut for the lime plasters and washes which are an essential part of the *Hadhrami* mud-brick house and an important component in the construction of flood defence works. They provide the initial defence against water penetration. *Nuura* plasters are used for waterproofing the outside of the house, particularly the roof. Foundations are made with a *nuura* and cement mix, and painted regularly after the house is complete[35]. It is vital for the effective waterproofing of lavatories, washrooms and kitchens. Exceptionally long-lasting, *nuura* is said to last up to 200 years[36] and evidence of the plasters has been found on pre-Islamic sites[37].

Limestone rocks are burnt at a very high temperature in a *madar* built kiln. Stones are collected from the wadi bed, or from quarries at the base of the cliffs. Other sources specify no particular place, for all the stone around is limestone[38]. The kilns, which resemble tall mud igloos, are usually situated in an open area, outside of the town. The kiln is fired using almost anything combustible: old tyres, oil, palm fronds and palm and tamarisk logs.

When the burnt rocks come out of the oven they crumble easily into a soft white powder. However, when mixed with water the rocks fizz and sizzle, get hot, crack and become hard again. The baked, watered stones are then taken to a *maHgaT*. The *maHgaT* is a 3' by 6' bed of large cobbles set in concrete. Water and the stones are placed on the lumpy surface and smacked with a 5'- 6' pole called a *miSbaT*. The *miSbaT* is raised above the head and brought down repeatedly on the *nuura* rocks until they are beaten into a thick paste. These days, machines are also used[39]. A barrel of pure, *miSbaT*-beaten *nuura* cost between 1100 and 1200 yr. at the beginning of March 1997[40].

There are four types of lime plaster and one wash, each with different grades and uses. The higher the proportion of lime to water, the more waterproof it is[41].

1. *ramaad*- (literally, ash). This plaster is pure lime mixed with ash, the by-product of the fuel used to burn the limestone[42]. Sometimes coarse or fine sand is also included[43], depending on the future use of the plaster. *Ramaad* was used in flood defences and foundations and is still used for the waterproof dado on the outside of *Shibaami* houses. It is also used to cover the large step around the

foundations of houses in Seiyun (*dikka-* pl. *dikuk*). After application to the *dikka*, a thin whitewash is applied[44].

2. *nuura* mixed with sand and cement: A new invention[45], it is commonly used for floors, and to coat the outside of stone foundations. For the latter it is called *Taraga* (this must not be confused with the *Taraga* described below, which is mixed with only *batHaa'*).

3. *Taraga-* Another plaster of *nuura,* this time mixed only with *batHaa'*[46]. *BatHaa'* (also called *niis*) is the extremely fine gravel, almost sand-like, from the wadi bed[47]. It is sifted before it is mixed with the *nuura* and water. *Taraga* is applied with a pointed metal float called a *Hadiida*[48], to the roofs and roof terraces (*raim-* pl. *riyuum*), and the outside of the house in its entirety if there is money to spare[49]. *Taraga* can last about 60 years[50], and hundreds of years if well-maintained and repaired.

4. *Taraga milis*, a very smooth plaster, and *rushuusha* (whitewash) are used within the house. *Rushuusha* is also used outside directly onto the mud/ chaff plaster (*taliiS* or *ghisaa'*) that provides the initial weather protection on the walls[51], and on the *dikuk* and foundations.

In the early 1980s, students at ʿAden University performed tests on cubes of various *nuura* mixes[52]. Three sample types were used: pure lime,

$^1/_4$ lime and $^3/_4$ ash,

$^3/_4$ lime and $^1/_4$ ash.

These samples were dried in the shade for 28 days. Table 3 shows the differences in shrinkage, density and crushing strength of the three types of cube.

	lime	$^1/_4$ lime	$^3/_4$ lime
shrinkage %	12	3	4
density grams/ cm^3	0.87	0.80	0.95
crushing strength Newton/mm^2	0.41	0.41	1.02

Table 4: Results of tests performed on blocks of *nuura*[53]

The report gave an estimated lifespan of 50 years for a roof plastered with *nuura* mixed with a small percentage of ash. By comparison, a pure lime roof might last about 15 years[54]. From the table, it is obvious that the lime samples of 3/4 ash were the lightest. There is not much difference in density. However, a substantial difference in shrinkage rates was noticed between the pure lime samples and those with ash added. It was concluded that the danger of cracking during drying lessened with the inclusion of ash. In addition the crushing strength of the 3/4 lime to 1/4 ash was higher than the other two samples[55]. The report concluded that the best plaster was the 3/4 lime to 1/4 ash combination.

After the *madar* and *taliiS* of a new house are sufficiently dry[56], the roof tops are spread with *Taraga*. This is the most important external area of the house to protect as the roofs are flat and collect water when it rains. *BatHaa'* is sprayed onto the damp *Taraga* so that the final layer of lime wash, *rushuusha*, adheres[57]. *Taraga* can be retouched yearly if blisters or cracks appear[58]. *Rushuusha* is repainted annually if money permits, before or after the rains if streaks of mud show through the lime[59].

Protection and Mitigation in House Construction

As the area is subject to flash flooding, it comes as no surprise that these mud-brick houses are constructed with aspects that aim to prevent the destruction of the house by flooding and by rain, and to lessen the extent of the destruction should it occur. In the Wadi Hadhramaut, the hazard of the flood is taken in the wider context of the whole rainstorm to include the houses that fell down as a result of rain penetration. Therefore, the protection given by the lime plasters on the roof are as important in the protection of the house as the foundations that protect the house from the rising waters of the flood. Houses in Seiyun are built traditionally with *dikuk*, great steps constructed around the foundations. Although these are now considered to be a continuation of traditional styles and primarily cosmetic, they do provide a degree of protection to the house during persistent rain and flooding. The slow collapse of the house is important in the safe evacuation of the occupants. As the occupants must regularly repair and maintain the house, their familiarity with both the construction materials and methods is vital in the repair of the house during and after the floods and rains. The cost of rebuilding is

relatively low and construction methods necessitate the slow rebuilding of the house. These aspects are important in the reduction of the financial distress of reconstruction in the aftermath of a disaster.

Foundations: prevention

The foundations are the most important deterrent in the *Hadhrami* house to flood destruction. Once flood waters rise above the foundations and penetrate the interior of the house, the house is usually doomed[60], and it dissolves "like a biscuit in tea"[61]. The solution to this has been the construction of massive foundations for houses in areas of potential flood risk. Certainly, in the eyes of the house owners and town planning authorities[62], the proximity of the house to a watercourse necessitates the construction of stone foundations to the estimated height that flood waters might reach. This is done at the personal expense of those who commissioned the house[63].

The height of the foundations is more important than the depth because it is easier for the flood waters to rise above the foundations and erode the walls than it is for them to undermine the foundations and cause instability. Near a watercourse, AHmed Jerboa[c] and his team increase the depth and height of the foundations from 1/2 m below and 1 m above, to 1 m below and 1 1/2 m above ground level[64]. Hassan BaaHashwaan also employed a specialist foundation maker[iv] to construct the foundations on his new house[65]. The foundations, which were made from squared rocks and cement, were laid to a depth of 3 *adhru'* below the ground. On the side of the house which edges a small channel, the foundations were also built 2- 3 *adhru*[c] above the ground[66]. Foundations on the other sides of the house were shallower[67]. For extra waterproofing, a plaster of *nuura* and cement, *Taraga,* is painted on the outside of the foundations[68].

Strong foundations are essential in the quarter of ʿAidiid in Tarim as many of the houses are constructed on the very edge of the watercourses. Plate 2 shows the extent of the stonework. All houses near the channel have high stone foundations, and although each house-owner is responsible for his own foundations and defences[69], the government assists through the donation of some cement and building materials[70]. A committee, set up to supervise the maintenance of the

[iv] Each part of the house is constructed by a different group of people. The expertise that specialisation brings to the building trade is good for the continuation of sound methods of construction.

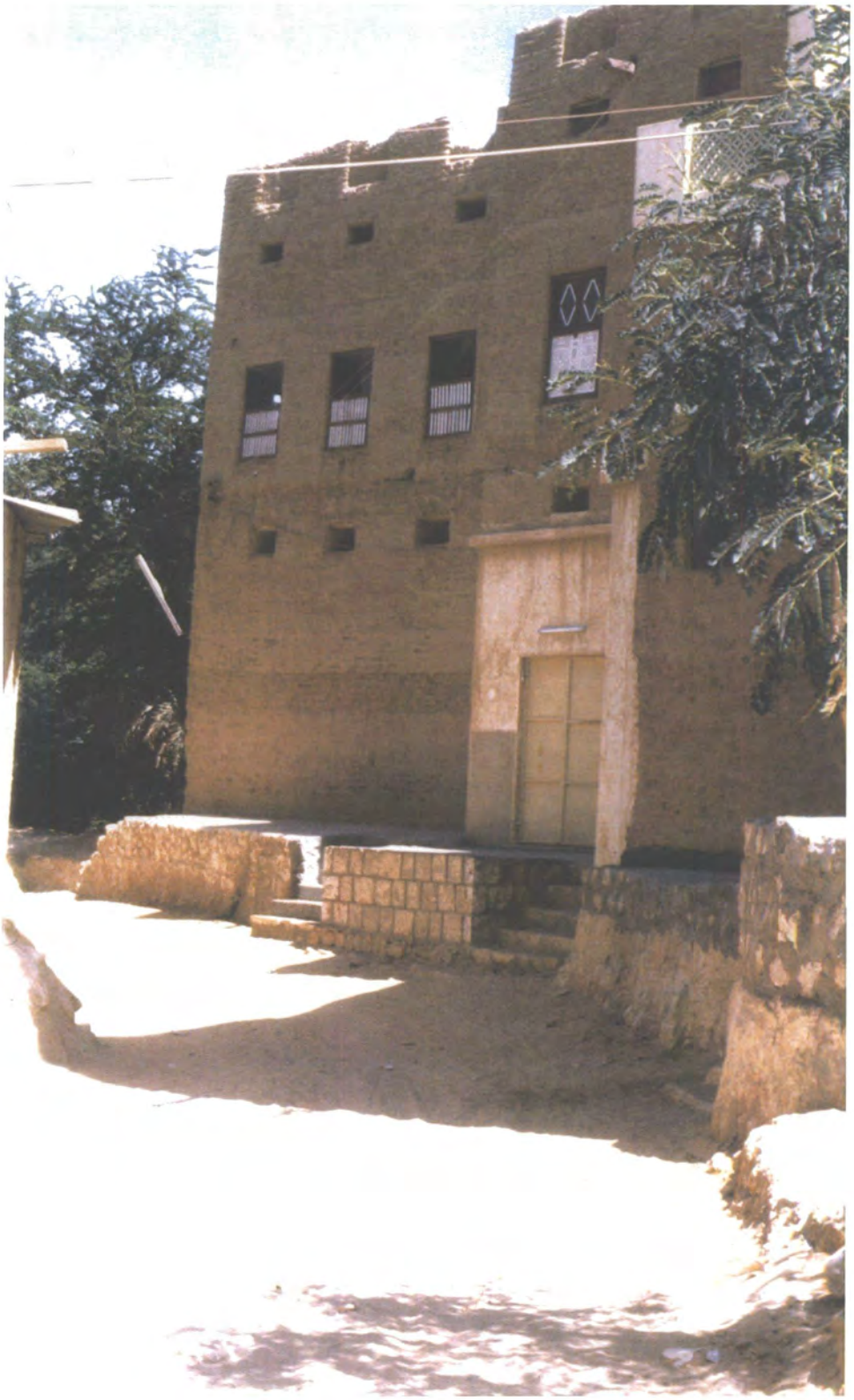

Plate 2. Substantial foundations used for a house on the edge of a channel in Tarim.

channels in Tarim, introduced a local law after the 1996 floods. The law made plans for the construction of substantial foundations imperative before a license to build could be granted[71]. This regulation was based on experience, of the houses with sizable foundations of cement and stones, none have yet fallen to floods[72]. In May 1997, a man working near a channel was forming cement and steel pillars to support the foundations for a new house[73].

dikka- dikuk, *protection*

Although *dikuk* are now largely constructed for cosmetic purposes, originally they were a defence against the waters that run rapidly off the *Jol* and form small channels that thread through the alleys of the high ground on which the old quarters of Seiyun are built. Today, *dikuk* still fulfil this purpose. The *dikka* acts as a step to the raised doorway, as the door is customarily built above the level of the unpaved alley[74]. This protects the house from rain and floods which, if the door were at street level, could intrude causing the house to collapse by dissolving the less substantial inner walls[75]. Foundations are also protected by the *dikuk* as they keep the water away from the true foundation. The mud and lime-plaster dado around the base of a *Shibaami* skyscraper performs a similar function. It is important to keep the water as far away from the foundations as possible so that seepage and subsequent ground instability will not affect the house[v].

Whether there was a legal requirement to construct *dikuk* is unlikely. Nevertheless, it was considered important enough for the *Baladiyya* (Local Authority) to encourage those building new homes during the Socialist period to incorporate *dikuk* into the structure of the house. ʿAbd al-Gaadr M. aS-Sabbaan mentions in his document on the role of the *Baladiyya* during his time of office[vi], that under Socialist rule it was very important to build *dikuk* around the base of a mud-brick house for the protection of the home[76]. Saalim Zain BaaHumaid, who also used to work in the *Baladiyya* in the 1970s, said that although *dikuk* were not required by law, during that period there were still no houses built without them because they are part of the architectural style[77]. In 1992, it was not a legal

[v] It is particularly important to keep the foundations of the *Shibaami* houses dry because the traditional method of foundation construction in the old town requires the use of salt and dried animal dung. Creeping water dissolves the salts which are then wicked up the mud walls with the water. The salts destroy the cohesion of the wall material and weaken the house.

[vi] From 1974.

requirement for Jamaal BaaHashwaan to construct *dikuk* around his house, but he chose to do so that the house might blend in with its older neighbours[78].

In the new areas of Seiyun, the villa style of the house does not include the construction of *dikuk*. Additional protection to the foundations and the lower walls is supplied by a stone foundation to a wall around the yard (*Hawsh*) of the house. This wall acts as the initial defence against the waters. If water does break-down the boundary wall and water overtops the remains, then damage to the house will be depend on the length of time that the water remains trapped in the yard and is absorbed into the structure, rather than the scouring effects of the fast-moving flood waters.

Lime wash protection

The use of *nuura* in the *Hadhrami* house is crucial to the longevity of the house. It is the only means of waterproofing the mud-brick houses used in the area. The house made with *madar* is vulnerable to the high intensity rainfall that precedes the floods and to the flood itself. Protection to the roof is offered by the *nuura* plasters[79]. If the roof is not coated in *Taraga* then the rainwater is absorbed by the *madar* roof, particularly if the house has poorly maintained drainage spouts. In heavy rainfall, the drainage spouts can become blocked with soggy mud from the dissolving roof. The rainwater then puddles on the roof and brings the ceiling down.

Lime plaster is, as proven by the ʿAden University tests, extremely hard and does not crack as a result of the diurnal temperature range because it expands and contracts with the weather[80]. If blisters do appear after a rainstorm, or cracks appear through age, then the *Taraga* can be repaired in patches. As there is no need to replace the whole roof[81], repair work on the *nuura* following rainstorms and flooding is fairly cheap.

Slow to fall

Despite the almost inevitable collapse of a house built too close to the flood zone, in the Wadi Hadhramaut few people die as a direct consequence of the destruction of their house. Since floods in the main channel of the Wadi Hadhramaut run relatively shallow and slow, *madar* houses affected by floods do not collapse immediately[vii]. In addition, floods in the main channel of the Wadi Hadhramaut do not carry large loads of hard debris because the distance from the heads of the tributary valleys allows for the depositing of the rocks before the floods reach the main Wadi channel[viii]. Scouring is therefore reduced. Mud-brick houses constructed too close to the flood zone collapse either by the erosion of the outer walls or by the dissolution of the interior walls. The height of the *Hadhrami* mud house therefore offers no protection in the event of a flood.

Despite the almost inevitable collapse of a flood affected house, few deaths occur since once a mud house starts to collapse it can take a while for the building to fully disintegrate[82]. ʿOmar al-ʿAamery said that a mud house will stay up for 7- 9 hours even if it is surrounded by water. The slow collapse of the mud house allows for the evacuation of the occupants and their belongings[83]. Flood waters can rise to quite a height in the house[ix] before the house collapses since it takes some time before the water penetrates through the *nuura* on the inner walls and into the structure of the house. Absorption rates are quicker in the inner walls[84] for the *madar* are smaller and thinner than those in the outer walls, and laid in the simple *maʿaroudha* method. The fact that the interior walls collapse first is an indicator of the strength of the *sabia wa maʿaroudha* method of brick-laying used in the outer walls, and the density of the larger bricks used. Great cracks in the outer walls appear as the house collapses into itself. When they see the cracks, the occupants know that the house will not withstand the flood[85] and so evacuate. Eventually the house dissolves into a large heap. It is said that, during the floods of 1989 when the area of MuHaidhara in Tarim was inundated, a woman gave birth on top of the pile of mud that had once been her home[86].

[vii] Mud houses in Shabwa that had been surrounded by the floods in 1996, had been washed away entirely. The valleys are steeper and narrower and the floods run more quickly, carrying more debris tumbled off the mountainsides and scooped out from the wadi sides by the water.

[viii] The bed of the main channel is mostly *baTHaa'*, the sandy gravel used in the *nuura* plasters.

[ix] In the floods of 1996, ʿAbdullah bin Hashlaan waded through the chest-high waters to inspect a flood-stricken house. The house was still standing (ʿAbdullah Saalim Bin Hashlaan, 4/3/97).

Low cost

Mud is a local and relatively cheap material with which to build, or repair, a house[87]. This is very important for ease of reconstruction following a flood event. Repair and reconstruction become less crippling for the stricken family if the cost is low, and the materials are fully available.

All the materials for the construction of a *madar* house are available locally. Since the materials do not have to be transported over long distances to the Wadi Hadhramaut, their prices are relatively low. Equally, as it is all so readily available, in the event of a disaster there is no delay while waiting for imported goods or people from outside the area to do the work[88]. The imported exceptions are wood and chaff. Wood for beams is often imported as the favoured local tree, *ʿelb*, is expensive and not often long enough to span a large room. Chaff (*tibl*) is sometimes imported from the Governorate of Shabwa. At 200 yr. for a 50 kg rice bag of chaff, it was considered expensive because one bag of chaff was needed for four wheelbarrows of mud[89]. However, should access to wood and chaff become difficult, then people can draw on local resources. Ideally, *madar* are made next to the building site to cut construction costs[90]. *Nuura* is often smacked close to the town centre, sometimes on the building site itself, also reducing transportation costs.

In both repair and construction there is a choice of expensive or cheap mud. The most expensive grade comes from the palm groves of Taaraba. In the winter of 1996, a lorry-load of mud from Taaraba to Seiyun cost 2000 yr.. A similar load of poorer quality mud transported from Buur to Seiyun cost about 1000 yr.[91]. *Madar* are sold in batches of a thousand. A thousand roof *madar* cost 6000 yr. in spring 1997[92]. Wall *madar* made with mud from Taaraba cost 7 yr. each, smaller ones used for the ceilings cost 5 yr. in the winter of 1996[93]. By way of comparison, a single round of pitta bread (*rooti*) also cost 5 yr.. Another source of mud is from demolished houses[x]. Old mud is free to those who would like to take it away from an demolished house. In 1992, Jamaal Baahashwan and his brother built a house in the old city of Seiyun on the spot of an abandoned house. The permit that they

[x] A number of Western authors have viewed the recycling of *madar* mud as irresponsible (Blanc, 1990), Lewcock, 1986), considering that mud from abandoned and collapsed houses will have lost its binding agents and be full of salts . The unanimous opinion of the *Hadhaarim* I talked to was that not only was old mud good to reuse, it was even stronger than it was when it was first used. They did, however, include two qualifiers: If a house fell down more than a hundred years ago then the mud is useless for reuse since it is all powdery and will not bind (AHmed Jerboaʿ, 26/5/97, Jaʿafer as-Sagaaf, 6/3/97). Mud from houses that collapsed due to flood waters should also not be reused for the water will have washed away the adhesive properties of the mud and the result will be a similar powdery mud (ʿAadil, 14/3/97).

were given to demolish the house also allowed them to reuse the mud to build one and a half storeys of the new house[94].

The fact that *madar* houses can be built one storey at a time, as the pocket permits, is an advantage as a stage of the house can be built as every thousand riyals comes in from charitable relations and monthly wages. Each stage has a specified drying time. Five layers of *madar*, about 1 ½' thick, are called a *muuthar*[95]. If a big house is under construction then drying times are reduced to about two days. By the time one end of the *muuthar* has been laid, the other end is dry[96]. This delay, however, can be a nuisance if the family is camped out in a tent or staying with relations.

If a house is hit by a flood and still remains fairly intact then there is no need to buy another licence[97], however, if the house is entirely washed away by the floods then the plans and summary have to be presented once again to the housing office[98]. At first a license is needed to permit the destruction of the remainder of the house, then another license for the construction of the new house[99]. Fortunately, the licence needed to construct a mud-brick house is easier to obtain than for a cement house. If all the plans and documents of ownership are in order, then the whole licensing process takes only one day to complete[100]. Floor by floor plans for a cement house are scrutinised more thoroughly than those for a mud-brick house because the processes of construction are far less familiar to the Office of Housing and Town Planning[101].

Cement houses

The construction of cement block houses has been on the increase since Unification in 1990. As cement block houses are still in the minority, the discussion of the merits and risks associated with its use are a minor issue. However, cement houses are becoming more and more popular. Many cement houses are being constructed for investment purposes by men who have worked, or are working in Saudi Arabia[102]. Some of these investments will stand empty for a while and it is to an absentee landlord's advantage that annual maintenance of his new house is not necessary, as it would be in a *madar* house. People have also started building in cement because it takes up less ground space than a *madar* house and can be built quickly[103].

Hadhaarim like to say that a cement house is more dangerous than a *madar* house because, once it does start to collapse, then it does so in one moment, without warning[104]. The easy familiarity and predictability of *madar* to *Hadhaarim* has probably spawned this bias. However, more people in the Hadhramaut are now using cement, particularly if they are building near a watercourse[105], for they do resist flood and rain waters more effectively than *madar*. Following the damage the floods inflicted on the Shibam SaHiil, houses were reconstructed with huge cement block foundations. In Shabwa, I met a family who had owned two adjoining houses; one of *madar*, the other of cement. In the 1996 flash floods, the mud house was washed away swiftly and completely while the family sheltered for hours on the roof of a cement house, even whilst the walls of the lower storey were being washed out.

Once a cement house has collapsed, the owner faces certain difficulty in reconstruction. Expensive to build, it is equally expensive to repair. Although labour for cement has become cheaper due to an influx of Northern workers, cement is more expensive than *madar* because of the additional costs of import and transportation[106]. To build in cement demands extensive savings as all the materials are imported[107], either from abroad or from, for example the Baajil cement factory in the TiHaama. Imported metal rods are also required throughout the construction, further increasing costs[108]. Unlike *madar* houses, a cement house has to be built without pause, necessitating considerable and readily available savings. Labour for flood damaged and destroyed houses has to be that of specialists rather than family and neighbours. The rubble is more difficult to clear than disintegrated *madar* and, because the house shatters and cracks rather than dissolving like a *madar* house, joining new sections to old is difficult.

Traditional methods of construction in the Wadi Hadhramaut are intrinsically strong, successfully mitigating the effects of the flood hazard through the use of methods that have been developed over the centuries. Protection of the house from flooding is achieved by the construction of substantial foundations. *Dikuk* further protect the foundations and impede the entrance of the flood waters to the house. The *nuura* coating on the rooftops is also important in protecting the house from the heavy rainstorms that precede the flooding. If the house does succumb to the scouring effects of the flood, the occupants are given sufficient warning by the appearance of gaping cracks in the outer walls well before the house finally

collapses. In reconstruction, the fact that a house can be built in stages lessens the pain of financial outlay. Repair work is often cheap since all the materials for construction are available locally. Nevertheless, the means by which a *madar* house is protected serve only as mitigation, true protection of a mud house is offered only by its site. This issue is addressed in the following chapter.

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Chapter 5

Town planning and flood avoidance

The most important aspect of a town's resistance to hazard is its site[1]. A mud house is not vulnerable to flash floods if the site on which it is built is safe, out the path of the floodwaters. A site situated far from the hazard-prone area is naturally less likely to suffer from the effects of that hazard. Once the choice of site is defined then the focus becomes the manner in which a town is planned. Inhabitants and businesses within the town should suffer as little disruption from a hazard as possible. Town planning must therefore localise and limit the scope of the disaster[2]. I propose that certain traditional aspects of town planning in the Wadi Hadhramaut have reduced vulnerability to flash flooding; towns are built on the high ground underneath the cliffs, on lower ground a system of channels has been created to disperse flood waters. These channels leave "islands" of higher land on which further developments of the town can be built.

Town Planning Heritage

Town layout is shaped by the cultural heritage of the region. Usually a settlement has both evolved and been planned. However, one must be careful not to idealise the past by judging the current layout of the towns. It is possible that floods destroyed just as many houses in those days as now, but without archaeological investigation, this cannot be shown. Unfortunately, for the purposes of amateur archaeology, flood-destroyed mud houses leave unprepossessing and short-lived remains. It must be assumed that, to a degree, the formation of the towns was based on trial and error. A town is dynamic; houses are constructed, others fall but rarely does a community move from the site if there are advantages in remaining[3]. While flying above the valley, one can see great swathes of land in the centre of the valley, uncultivated and unsettled. That the land in the centre of the valley is less favoured for settlement indicates that there must be reasons for settlement close to the tributary wadis and the edges of the mountains. The towns in the Wadi Hadhramaut have been shaped by the need to be close to the watercourse to utilise the floodwaters and the fertile silts of the alluvial fan. To protect the town from

floods, and to maximise the land available for agriculture, houses were built close together on the barren higher ground[4]. Keeping to the heights was also important for the protection of the towns during tribal disputes.

Settlement in wadis threatened by flash flooding has been encouraged by the very hazard that makes life in them risky. The need for water in this arid region and the attraction of the fertile silts brought down by the spates, has drawn farmers to the valleys. The quality of flood water is sweet and so is suitable for both irrigation and drinking[5]. The quantities of water which constitute a flood wash away the salts accumulated in the soil through evaporation. Flash floods in the Wadi Hadhramaut carry large sediment loads[6] since the sandy soil of the Wadi Hadhramaut is easily scoured, failing to hold palm or *'elb* trees securely in the face of a flood[7][i]. The sediment that is deposited by the floods is very important for replenishing the fertility of the soil.

Most of the settlements of the Wadi Hadhramaut and its tributaries are rural villages, the four main towns being the only settlements of significant size. Even in the 1960s, the population of the Hadhramaut was primarily rural, dependant on agriculture and concentrated around water sources[8]. Urban Wadi Hadhramaut was also dominated by agriculture[9], Seiyun was reputed to be the city of a million palm trees. Although ground water in the Wadi Hadhramaut lies close to the surface[ii], until the introduction of diesel pumps, water still had to be drawn by hand or by donkey. This, of course, is too labour-intensive a system to be a viable option for irrigating large areas of palm groves and fields. Therefore, to sustain crop growth in this arid area, agriculture was dependant on spate irrigation. Date palm cultivation and the seasonal crops growing between the palms took place near the watercourses so that the groves could benefit from the flood flows.

[i] In the governorate of al-Baydha, sediment loads of floods were estimated as 2.8% by weight. The reservoirs behind the land formation dams throughout Al-Baydha usually silt up within a period of 3- 8 years (Rada Integrated Rural Development Project, (1986).

[ii] In 1972, the static water level in the Wadi Hadhramaut was between 5 and 30m below the surface. The static water level in the central strip between Wadi Huun and the village of Buur, and between Shibam and Qatn, and between Buur and HawTa was about 10-15m. There are fluctuations of plus or minus 1 metre in the static water levels depending on the flood (Dar al-Handasah Engineers and Architects (Shair and Partners), 1972).

Avoidance

The essential proximity of the settlements to the watercourses necessitated the careful avoidance of the floods that they carried in the rainy seasons. Construction on the high ground was vital for avoiding the floods. In building the towns on the unproductive ground underneath the cliffs, the fertile land by the watercourse was made fully available for agriculture. The oldest areas of all three towns are characterised by closely-packed tower houses and narrow alleyways, constructed on the gentle slopes of the valley edges or on raised outcrops. The first quarter of Seiyun spread west from the Sultan's palace, the second extended southwards[10].

Tribal warfare and raiding played a large part in the politics of the valley until the peacemaking efforts of Harold Ingrams and key leaders of a few tribes in the 1930s. Settlement on the high ground was attractive for it gave the settlement a strategic position in the event of a raid. Consequently, most of the towns and villages throughout the valley are built on the slopes beneath the cliffs. Shibam, Tarim and Seiyun are also built on the higher ground. The old town of Shibam is built on a little hillock, located slightly towards the centre of the valley[11]. It is a strategic position, in keeping with the historical role of the town as the capital of the Hadhramaut[12]. It is situated at the convergence of several tributary valleys, surrounded by fertile areas, and once occupied a key position on the ancient spice and incense route[13].

The political instability of the area limited expansion of the towns since the construction of houses within the town walls was preferred. Each of the three towns had a castle and a surrounding wall. In 1937, W. H. Ingrams reported that the wall of Tarim was over five miles long and incorporated five gates and twenty-five forts[14]. On each corner of Shibam's *suur* (town wall) was built a *kuut* (watchtower) from which patrolling watchmen would blow conch shell trumpets[15]. Shibam's growth was curbed by the continuing conflict between the two ruling families of the Hadhramaut. The rivalry between the al-Kathiiri and al-Qu'aiti that lasted until the middle of this century sultanates centred on Shibam. The only option for expansion was in SaHiil, outside the defensive town wall. Not a compelling proposal. That it did not expand like Tarim and Seiyun[16] has been to Shibam's advantage. Encroachment of the watercourse by housing has only recently taken place.

Of the three towns, only the town wall of Shibam now remains in its entirety. Originally built for defence, the town wall of Shibam is also crucial for the protection of the town from floods. If the main channel carries large quantities of water, the floods undermine the town wall on one side and endanger the houses in SaHiil on the other. The soundness of the town wall is essential as it contains the hillock on which Shibam is built, preventing destructive ground movement that causes the houses above to crack and fall. Houses on the corners of the hillock are particularly vulnerable to the effects of subsidence when the wall is in disrepair as they rely on the stability of two sides of the *suur*.

Houses traditionally have been constructed along vertical rather than horizontal lines so that effective use is made of the limited land at the base of the mountains and within the town walls. The skyscrapers of Shibam are the epitome of space-saving architecture, a cluster of seven-storey tower houses huddled together on an outcrop. Further space is saved since the traditional house has no garden, goats and children roam around the alleys[iii]. Houses built close together and separated by narrow alleys provide shady walkways out of the glare of the sun. The winding nature of alleyways in the unstructured older quarters also restricts the velocity of the runoff that pours off the mountains during a rainstorm, and reduces the damage they inflict.

Flood Dispersal Networks

Over time, segments of the alluvial fan on which Seiyun and Tarim are built were created and consolidated by flood erosion and deposition, leaving distinct channels between them[17]. Since water storage in the Wadi Hadhramaut is difficult because rainwater runs off and evaporates very quickly, these channels were exploited by farmers to maximise the use of floodwater for agriculture. Farmers were dependant on diverting and dividing spates by an elaborate systems of channels, weirs and bunds based on the natural channels. Early photographs of Seiyun from the 1930s [18]clearly show the existence of these channels running from the south into the palm groves of al-Himma. These channels have become the main feature of modern town layout in Seiyun (see figure 7) and Tarim. The tree-like networks of channels and alleys carry water in times of floods but, for the majority of the time,

[iii] In the past, small livestock used to be taken outside the town wall of Shibam in the morning by two designated herdsmen, the hiring of whom was organised by the sheikh of each quarter. At dusk the animals would be brought back into the town, having been fed and watered in the palm groves outside the gates (Pridholm, 1985).

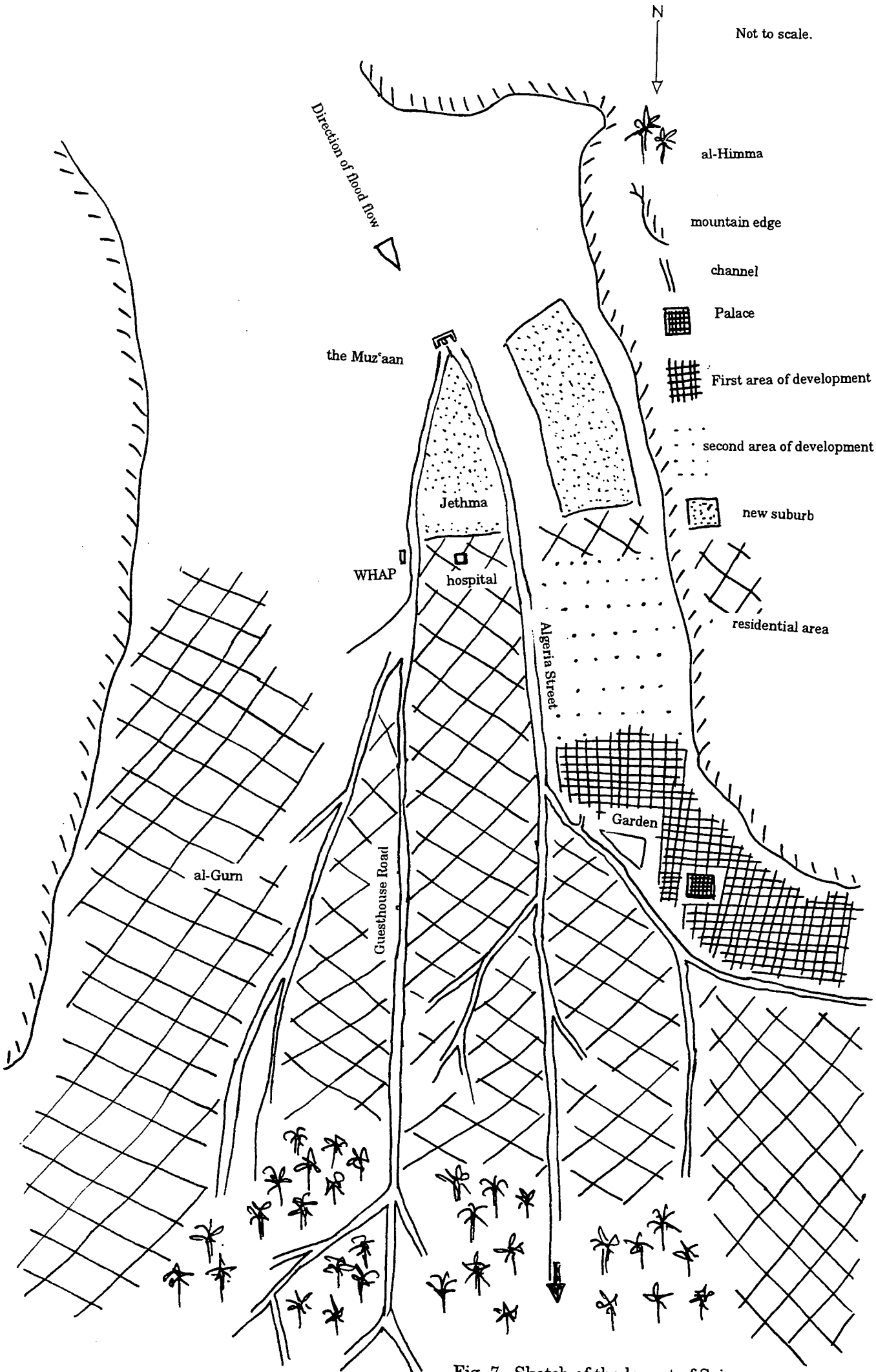

Fig. 7. Sketch of the layout of Seiyun.

serve as roads. House construction on the patches of high ground between the channels started in the 1930s, thus continuing the principles of flood avoidance[19].

The "tree" starts far up Wadi Jethma with an E-shaped weir, the muz'aan, which divides flood waters into two parts. The water, which is split into two fifths and three fifths[20], is channelled down the two main roads in Seiyun, Guesthouse Road and Algeria Street (*Shaari' al-Jazaa'ir*). The two main roads/ channels are both generous cobbled two lane roads with central reservations. Algeria Street was widened in the 1950s following the destructive *Sail as-Saba'* (c.f. appendix 1)[21]. Since it is close to the city centre, Algeria Street is the most important and busiest of the roads in Seiyun.

Minor roads lead off from the two main roads. The majority of the roads are unpaved, hard-packed soil forms the road surface. Dispersal is continued as the water is guided down increasingly minor roads and alleys, sometimes into palm groves within the town. At one time, there were 80 or more mosques in Seiyun, all of which owned groves in the town. Fed by a combination of spate irrigation and well water, the income generated from the sale of dates would pay for the upkeep of the mosque properties and its employees[22]. Stone or mud bunds and weirs (*murSad*) have been built to assist water diversion. Most of the structures around Algeria Street and the garden in the centre of the town, were built by the Kathiiri Sultans at the end of the 1950s and beginning of the 1960s, using a grant from Britain[23]. Within the town, most of these roads are edged by low walls of stone, cement and *ramaad* (lime and ash cement).

The majority of the roads in Seiyun head north to al-Himma, an area of palm groves and fields. Here the roads continue to divide into unpaved tracks, conducting flood waters into the fields. Mud bunds give protection to the fields, tracks and houses. If there is any excess water, it runs out of al-Himma and across Airport Road, over some undeveloped land and into the main channel of the Wadi Hadhramaut.

Channels in Seiyun are wider than those of Tarim. None of the channels in Tarim are wide enough to accommodate a two lane road like the two main channels in Seiyun: Algeria Street and Guesthouse Road. The extra channel width available in Seiyun is an advantage. Rising times in the channels of Tarim is rapid, in Seiyun the flood waters rise more slowly[24]. The extra capacity of the channels in Seiyun

allows for the throughflow of large quantities of water without their rising to a great height in the channels. However, channels in Tarim are more plentiful than in Seiyun. The greater numbers of channels almost compensate for their lack of width.

Indigenous, *ad hoc* systems can often be exceedingly effective as they are tried, tested and maintained by the community. This method of dispersal by diversion works by reducing the intensity of the flood flow and therefore its capacity to damage. It is a cheap method, requiring only one simple network. Those in the agricultural sector benefit from the water diverted to the fields, and yet still have easy access to the city. Since the channels are also roads, people tend not to block them with refuse [25]or allow trees to grow in them. Although keeping the drainage and road systems separate is recommended as a town planning principle so that the floods do not endanger those using the roads or prevent the injured from being taken to hospital, there is little risk to car drivers or residents. Even if a flood were to rise, a car can quickly drive onto one of the many higher patches via the numerous roads. As Wadi Jethma (Seiyun) and the little wadis that run through Tarim carry water for only a few hours, the roads are quickly dry enough to transport people to the hospital at the top of Algeria Street. This is not usually necessary, few people are ever injured by a flood as a direct result of the flood.

The Muuzaᶜ

As Shibam is situated towards the middle of the valley, adjacent to the main Wadi Hadhramaut watercourse, protection of the town demands slightly different measures of protection to Seiyun and Tarim. Shibam once stretched from its current site, across what is now the Wadi channel to the mountain base, now the suburb of SaHiil. The hazardous Wadi Saar once flowed harmlessly to the north of the city[26]. It was probably in 1532 that floods carved a new watercourse. Much of the city was destroyed when the new channel was gouged out through the southern side of town. Only the small island of houses towards the centre of the wadi was left. This has remained the nucleus of Shibam (see plate 3).

After the disastrous floods of 1532, it was necessary to build some form of flood defence to protect the town from the force of combined floods from Wadis Duᶜaan, ᶜAmd, al-ᶜAin and Saar[27]. Rather than splitting up the water into smaller and weaker rivers, flood waters at Shibam are controlled by a system of weirs in the

Plate 3. Looking north over Shibam and the watercourse, showing SaHiil in the foreground.

middle of the watercourse that stretches back to the tributary wadis[28]. The system involves two types of weirs, one type is constructed across the wadi bed to curb the speed of the water, the other diverts some of the water to channels that feed the irrigation network[29].

The most important, and the penultimate, structure of the system is the Muuzaᶜ, a 700m long[30] diversion weir made originally of stones bound together with *ramaad* (see plate 4), a more weather-resistant plaster than the brittle cement that has become popular for repairs[31]. It is joined to the bank by a large mud bund which acts like a fuse in major floods when it breaks to prevent the irrigation network from being washed out[32]. SaaleH Saghdaara believes that members of the village above Shibam, al-Agad, breach the bund in the event of a major flood by repeatedly firing a gun at one small spot on the bund[33]. The main irrigation channel takes water from behind the Muuzaᶜ towards Shibam, 4 kilometres to the east, where it is dispersed via smaller channels and gates into pond-like fields[34]. (See figure 8)

As the flood dispersal network in Seiyun and Tarim serve three masters; town protection, communication and agriculture, so the system at Shibam both protects the town and carries water to the palm groves to the west and the north of the town. The watercourse is not a road, although the road does cross it. The double incentive to keep the Muuzaᶜ and its sisters in good repair is fine preventative strategy. Since its construction, the Muuzaᶜ has been regularly repaired and there has been no major damage to the city[35].

Plate 4. Section of the Muuza'.

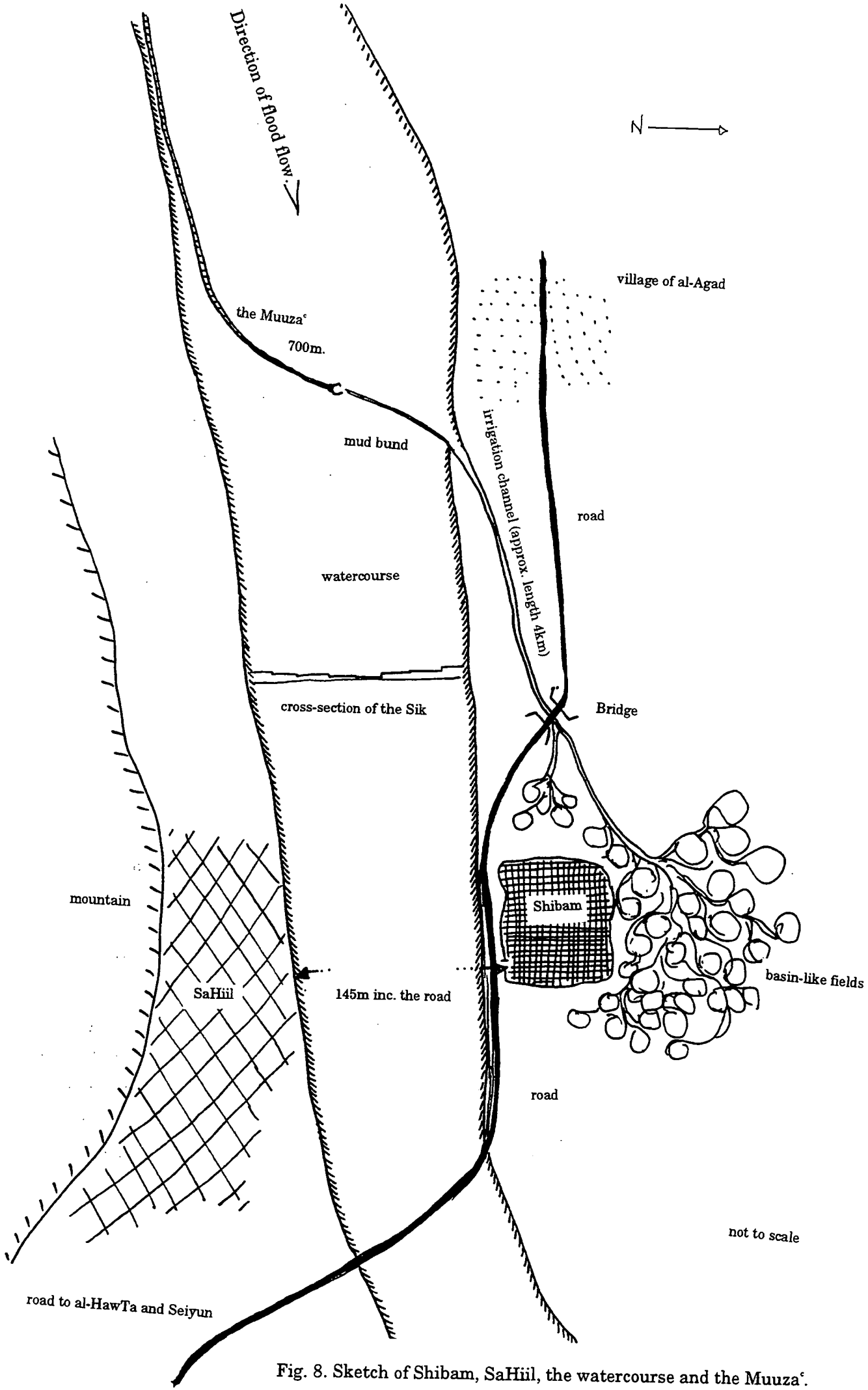

Fig. 8. Sketch of Shibam, SaHiil, the watercourse and the Muuzaʿ.

The two principles of constructing houses on the higher ground and controlling the waters on the wadi bottom seem to have been important for the continued protection of the three towns; Tarim, Shibam and Seiyun. The desire to build on the elevated ground underneath the cliffs was based on the need to protect the town from floods, make the best use of the lower ground for agriculture, and to maintain the strategic higher ground in times of unrest. In Tarim and Seiyun, the channels on the valley bottom used to maximise the flood waters for agriculture have been gradually modified to carry traffic. The islands left between the channels have recently become more important for construction than for agriculture. Shibam is protected by the town wall that once doubled as defence against both floods and attackers. The Muuzaʿ is also vital because it diverts flood waters to the crops and trees growing in the basin-like groves to the north of the town. In doing so, it reduces the amount of water flowing through the central watercourse.

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Chapter 6

Traditions, Prevention and Mitigation

It is not just careful town planning and integral strengths in building that determine the likelihood of the town's survival in the event of a flood and limit the scale of the flood. The active participation of the inhabitants in prevention and mitigation is vital. The agricultural tradition that shaped the town has also influenced the communities' reaction to the flood hazard. As floods are essential to every community that relies on spate irrigation, floods were anticipated hopefully in urban Wadi Hadhramaut. Experience gained from a history of harnessing floods for agriculture has resulted in the accumulation of wisdom and traditions that warn people of the dangers of flooding. The links between co-operation in agriculture and co-operation in the urban setting are not a new phenomenon, the Muuza' diversion weir system was initially constructed both to protect the town and to make the best use of the flood waters. Patterns of co-operation were developed both within the smaller community of family, friends and neighbours, and in the larger communities of quarters and towns.

Local Knowledge and Experience

A community is better prepared for a hazard if they have experienced it before. In emergencies, the more accustomed the community is in responding to the situation, the easier the response. As shown by the flood summary of table 2, the three communities are subject to regular flood events. Flooding is not, therefore, an unusual and unprecedented event so the community remains aware of the nature of flooding and the associated risks. This awareness is vital in the effective propagation of measures that decrease vulnerability to the flood hazard. During minor floods, the community is given the opportunity to practice, albeit on a smaller scale, methods of dealing with the flood and its effects that will enable them to cope in the event of a major flood. The reactions of a community that survived a major flood event to a repetition of the hazard will be affected by their experience[i].

[i] For instance, an experienced community will treat the hazard with respect and are likely to modify construction methods accordingly and avoid areas once affected by the hazard.

Floods have an important place in Yemen's history. Frequently cited in reference to floods and disasters are the two failures of the famous Maarib Dam in 520 and 650 AD[1] which caused flooding in the Maarib area. The historical record of flooding traditionally begins with the creation of the Wadi during the lifetime of Noah. H. Ingrams records a conversation he had with a man in the Wadi Du'aan during his travels through the Wadi Hadhramaut into the Maseila in 1934:

> Ingrams " It seems extraordinary to find all these people living in a river bed, " I said. "Don't you ever have any big floods?"
>
> "It is a long time since there was a big flood, " said Ahmed, "about three or four hundred years ago. The wadi was flooded from Rehab and four thousand date palms were washed away."
>
> "The walls of the wadi are so clear cut that you'd think they had been cut yesterday."
>
> "Ah, that was in the time of our father Nuh. The whole land was covered with water. Nuh and his family built a big ship and lived in it while the flood lasted. When the flood subsided and the water ran away there were big rivers: that is how these wadis were cut out and why you found the seashells you told me of."[2]

Just as the community guards flood stories, so too do families have their own tales. Sa'iid 'Abd al-Khayr's grandfather, Bakri, was drowned in a flood.

> Bakri worked with headcloths and material. One day he was walking from al-HawTa to his home in Shibam, carrying a bundle of materials on his head. In order to get from al-HawTa to Shibam, one has to cross the main watercourse of the Wadi Hadhramaut. On this particular day, the watercourse was carrying the beginnings of a flood. Bakri stood on his pile of cloth at the edge of the channel, waiting with his friends for the flood to subside. They waited until after sunset when the impatient Bakri determined to go to Shibam. His friends warned him that the current was getting stronger and urged him not to go. Nevertheless, he started to walk across. In the middle of the flood flow, the water pulled his feet from underneath him. As he was being swept along, Bakri placed his cloth on a small palm tree, his hat on a bush, wrapped his dagger in his shirt and sarong and put them in another palm. Naked, he let the flood take him. His family found his body three days later in MaHdooda. It stank. They wrapped their faces with cloths and buried him where he lay[3].

This simple narrative conceals useful information:

It gives an approximate time for flooding: due to the intense sunlight, no-one walks around in the Wadi Hadhramaut at midday, Bakri would therefore have been walking back from al-HawTa in the late afternoon. The flood must have started flowing at about that time, following an afternoon rainstorm. The flood is described as continuing to rise until after sunset[ii]. The flood could therefore be the result of a convectional rainstorm, probably in a tributary valley as Bakri would be less likely to walk home had it rained over al-HawTa and Shibam. The flood probably flowed for two or three days.

It demonstrates that floods are often too strong to walk through or swim in, particularly in the rising stage of the flood. It is more likely that the flood whipped the clothes from Bakri and carried them until they were snagged in the trees, than they were placed there by a man resigned to death. The strength of the flood is anticipated by the reaction of Bakri's friends to his decision to walk across. However, that he tried to traverse the watercourse reveals that it can sometimes be achieved safely. Apparently, while a flood was still low, the inhabitants of SaHiil Shibam would swim over to the market in old Shibam[iii] to buy foodstuffs to avoid running out of supplies during the flood period[4].

The story gives a hint of the practice of following the flood to retrieve and bury the bodies of those taken by the flood[5]. The low numbers of missing persons following the June 1996 floods (cf. Appendix 1) can be attributed to this practice.

The effective sharing of knowledge associated with rain and floods, and the historical significance of past flood events is achieved by the reciting and performance of poetry and songs. Songs and poems are easily recalled since their rhythm and tunes embed themselves in the memory. Musical evenings are a communal affair, often taking place in celebration of a wedding or holiday. Although the types of songs that are sung and poems that are read depend upon the tastes of the audience and the occasion, it is not unusual that a performance of epic flood be included. R B Serjeant notes that rain and floods are a recurrent theme in *Hadhrami* poetry and songs, often in the introductory lines[6]. That such narrative songs are recited in sung in groups is notable, awareness of floods is maintained within the communities. Sa'iid 'Abd al-Khayr, a professional singer, sang and

[ii] Between 17:00h (winter months) and 19:00h (summer months).
[iii] The townspeople of old Shibam were accustomed to maintaining large stores, a hangover from the days of tribal unrest and town sieges. This stood them in good stead in the event of a flood cutting them off from the outside world ('Abdullah Saalim Bin Hashlaan, 4/3/97).

explained for me an epic song composed after the floods of 1989 by Hassan ʿAbdullah BaaHaarathy. Here is a translation of the first two verses:

The flood by the highlands and the lowlands flowed
From the head of Duʿaan and from Wadi Saar.
Even lofty Shibam is low compared to the flood.
This strange thing whitens the hair,
There is no escape from destiny.

From the East, from the North, as far as the eye can see,
Rain clouds gather, bearing down on the trees.
The flood comes from all directions, and besieges esteemed Tarim
But it is shielded by the Lord,
There is no escape from destiny.

The song provides evidence of the origins of the floods, Wadis Saar and Duʿaan, and the extent to which urban Wadi Hadhramaut was flooded. No mention of Seiyun is given in the song for it was untouched by the floods[7]. According to Serjeant, poems exist in the Wadi Hadhramaut that used to be sung specifically by ploughmen working in flood-irrigated fields, often in the form of responses[8]. Some songs enabled people to sing through the patterns of work. Since nuura workers still sing their work-related songs, it is likely that these songs and poems are still sung today, although perhaps to a lesser extent with the proliferation of diesel pumps.

Proverbs are another means by which wisdom regarding floods can be remembered. Just as poetry and song spring to mind through their catchy rhythm and rhyme, so do pithy and repetitive proverbs. The *Hadhrami* proverb:

iHdhr min thalaatha, al-ʿabd, al-thawr was-siyuul
Watch out for the slave, the bull and the flood[9]

demonstrates the volatility of the relationship between the agricultural sector and the flood hazard. Bulls, slaves and floods were all important to agriculture in the Wadi Hadhramaut, even in this century. Bulls were used for dragging the plough, slaves for labouring, and floods for irrigation. However, each of these have also an unpredictable and dangerous side: bulls are renowned for their temper, and irrigation networks exist under the threat of the destructive power of flash floods. Slaves were kept as part of the private armies of the Sultans of the Hadhramaut and as arms-bearing members of wealthy households[10]. Their access to power and weaponry, and lack of personal freedom, necessitated their careful management.

Preparation for the floods is possible if sufficient warning is given. Over the years, various methods of analysing the weather have been developed and summarised in proverbs. The elderly are credited with the ability to discern through their bones when rains will come and what type of rain they will bring. Apparently they can tell the difference between a sea wind, a mountain wind and a wind that bring dangerous rains[11]. A proverb that is quoted in both the Hadhramaut and in the Western Massif[12], warns people to get out of low and vulnerable areas should lightning strike in the north-west:

idha baragat min al-gibla, tarafa'a fawg ya Taarif

If lightning flashes from the direction of the Qibla (direction of Mecca, north-west),

then get up to the high ground you who live on the edge (of the mountain or valley).

This proverb in the Wadi Hadhramaut could refer to the danger posed to Shibam by the heavy floods that result from rainfall over the north-western Wadi Saar. Hassan BaaHashwaan claimed that if lightning flashed in the south, people were unconcerned[13]. By contrast, Serjeant records that *Hadhaarim* consider a south wind to be important during the flood season:

Shaara bilaa baHry kamaa bab artakab ma luh gawaam

"Rains (and floods) without the *BaHri* wind,

Are like a door set up without supports."[14]

Since the *baHri* (sea) wind carries the majority of rain that falls in the catchment areas of the Wadi Hadhramaut, this saying is particularly appropriate. A flood that results from a convectional rainstorm, or is carried from any direction other than from the sea, will obviously be smaller, of shorter duration and therefore of limited use to agriculture.

The Yemeni Almanac of MuHammad Haidarah, compiled before 1945, lists traditional indications and portents for almost every day of the year. These include recommendations for daily life (May 9, "Lemon drink is used.". May 10, "Eating of salty things is avoided."[15]), but are primarily linked to the agricultural seasons. So that agricultural activities such as sowing, winnowing and fertilising take place at appropriate times, weather patterns are predicted:

January 15, "Rain is expected. Grafting of vines"

February 22, "The last of the blowing of the South Wind..."

March 11, "The first of the violent wind (*al-husum*), and the days of intense cold (*al-'adjuz*)."

March 16, "... The days of violent wind (*al-husum*) come to an end."

April 2, "Beginning of the fall of the rains in the East and South East of Yemen until August."

April 19, "The beginning of coming down of the rains from the hill slopes. Palm trees are fertilised."

April 27, "The blowing of the North Winds (*shimal*)."

May 5, "The South Wind (*Djanub*) blows, and the wadis expand and over-flow."

June 3, "The falling of the rains begins in the high ground, and the flowing of floods (*sail*) in Tihama."

June 9, "The West Wind (*Dabur*) blows."

June 18, The fall of the rain-period (*nuktah*) on Tuesday night."

June 22, "The rain-period (*nuktah*) of Cancer (*Saratan*)."

June 23, "The period of the blowing of the hot wind (*samum*) for 70 days.."

June 27, "The waters sink into the earth, and the breeze (*hawa'*) lightens."

June 30, "Close of the season of rain in the hill-slopes..."

October 26, "The *Azyab* wind blows from the N.E. to the S.W."

November 17, "The South winds (*riyah al-djanub*) blow."

November 19, "The moistness of the atmosphere commences."

November 21, "Mists (*ghaim*) are frequent."[16]

Although the information recorded in this almanac has not been attained through modern scientific methods, there are important observations which correspond very closely to the geographical background given in the section in Chapter 3. The "violent wind" that blows between March 11 and 16 heralds the period of spring rains that fall intermittently in March and April. Late April is characterised by winds from the north. These are dry winds, having passed over the Rub' al-Khaali desert before reaching the Wadi Hadhramaut. El-Tash and Ismail (1987), and Binnie and Partners (1987) record that, in the summer, the wind in the Wadi Hadhramaut comes from the south west at about 4.4 km/hr. In the winter months, the wind usually comes from the north east at a mean velocity of 1.8 km/hr. This data is also documented in the Almanac (May 5 and June 9, October 26). Records shown in Appendix 2 show very low levels of rainfall in October[17]. Once again, the link between the south winds and rainfall is shown in the appearance of mists in November.

The month of June has more references to weather changes and rainfall than the other months. This corresponds to the patterns of rainfall charted in the tables in Appendix 2, and to the flash flooding of June 1996. The coincidence of the

prediction of June 18 with the heaviest period of rainfall and disastrous flooding that Yemen experienced in 1996 is remarkable. The Almanac anticipated winds from June 9. The 1996 rainy season started with a few days of hazy and windy weather, beginning in most areas on June 14[18]. For fifteen days before the rains began, the town of NiSSaab (Shabwa) was swept by strong winds and stinging dust storms[19]. In the Hadhramaut, the unsettled weather started on June 12 and lasted until June 17. High floods flowed for three uninterrupted days[20]. The period of flooding in 1996 was indeed followed by a period of strong hot winds, just as the Almanac predicts.

Co-operation and Preparation

Throughout the Hadhramaut, the construction and maintenance of diversion weirs was the job of the community. The continued maintenance of the structures which both utilised the flood water and protected the settled areas around them was vital to the safety of the local communities, and to the well-being of the local economy.

Labour and money for the repair of weirs and bunds were contributed in proportion to the amount of land and palms owned in the area. The more palms a family owned, the more money he had to contribute. A sheikh was often responsible for the collection of money over an area between two weirs[21]. More money had to be contributed if the land was closer to the weir, since the weir offered the land extra protection and, more importantly, trapped rich silts immediately behind it[22]. At the end of Wadi Thibi is a structure that divides the flood waters into smaller channels and diverts them to fields at the side of the main channel. Before the Socialists assumed power, it was customary for the local farmers to regularly dig out the accumulated silt in the channels and to use the soil to raise the bunds which separated them[23]. In the early fifties, Great Britain gave a loan to the owners of the fields just outside Tarim. With the money, landowners built gabions to protect the fields from being scoured by the floods. These defences consist of large stones cemented together and overlaid with a metal mesh[24].

A tradition of compulsory labour, corvée (*wakad*), existed throughout the Wadi Hadhramaut before the ascendance of the Socialist regime. The Sultan, for example, could request and compel the labourers in the community to work for him at reduced rates in the construction of a palace or fort. A *wakad* could also be issued for work that was for the benefit of the whole community by the head of a

sacred enclave, or by the head of a tribe. Damage to large dams or weirs was often repaired by groups of labourers from the community acting in response to a *wakad gabiila* (tribal *wakad*)[25].

The proximity of Shibam to the main watercourse of the Wadi Hadhramaut has ensured its affliction by floods for much of its history (c.f. Appendix 1). As a result, the inhabitants of Shibam have a more ready knowledge of floods than the other two towns. The maintenance of the comprehensive system of flood defences that culminates in the Muuzaᶜ diversion weir, lay with the community for hundreds of years. This universal involvement ensured a community-wide awareness of both the threat of floods and the importance of repair to the diversion weirs. From its construction in the 16th century until about forty years ago, the Muuzaᶜ and the system used to be maintained by the people of Shibam, supervised by a man called *al-lijaan*[iv]. The *lijaan* would walk around the Wadi to find areas of potential damage. He would then collect money, amass helpers from the community and together they would fix the Muuzaᶜ[26]. A similar role existed in Wadis Duᶜaan and ᶜAmd where the man was called a *khaayil*[27]. Saᶜiid ᶜAbd Al-Khayr recounted that when it flooded, everyone in Shibam took a break from the normal routine for almost a week. Once the water had receded then the men would repair the damage to the irrigation and the diversion weir networks[28].

Celebration

Traditionally, parties were held on the arrival of the floods, for regular floods were regarded as a blessing in Shibam, Seiyun and Tarim. This indicates that the event of a flood was within the expectations of the community, and that people were prepared for the flood. The sudden abundance of water in this arid land was celebrated for the benefits that it brought to agriculture and drinking wells. Fields and gardens were watered, and the water table was raised, profiting the drinking water supply[29].

Of Universal Benefit

The advent of the floods was a desired event. R B Serjeant records celebrations held in the village of Huraidha at the end of the date harvest in 1954. A group of

[iv] Not his name, but his role.

villagers danced and sang throughout the village, stopping under the windows of many of the houses to sing:

"Who's house is this? May it prosper,

May the good God save its master."

Dates are then scattered from the windows of the blessed house, accompanied by the ditty:

"Be there, O God, upon ʿAibun,

From each lightning, a flood that flows,

At each early morning time, a flood,

At night a new flood that follows."[30]

This custom clearly shows that floods were considered a great blessing rather than a curse, based on the necessity of spate waters for the cultivation of dates and other crops.

Rain and floods were beneficial to the whole community. Even if a family owned no land, common land provided certain advantages. Goats were able to graze on the now plentiful grass that had sprung up on common land[31]. After the rains and floods, two types of gourd grow in the wadi bed: *Hadaj* and *fagouz*[32]. *Hadaj* is bitter and inedible, but *fagouz* is collected to eat[33]. The *fagouz* gourd is best boiled in a little water and eaten with meat as it has laxative properties. Apparently, it is particularly tasty if eaten with rice and cooked dried shark meat (*lakhm*), a local staple[34]. People also collect the fresh leaves from two types of trees that bud after the rains and floods. The leaves of the soap tree, *Hataiga*, are gathered and ground. After rains, it is possible to buy handfuls of these leaves in the market from entrepreneurial gleaners[35]. People use the ground leaves to rub over their bodies as a lather-less soap. After the floods, another tree, *lijn*, bears leaves which are used to clean hair[36].

Shibam used to depend heavily on the wells situated in the Wadi bed, of which there were about 80 in the 1960s[37]. Many families had their own well, or *Hissi*[v], and from it would draw their drinking and washing water, and water for their animals. Each *Hissi* had a name, a surround like a oversized millstone, and was often lined with *Taraga*. After a flood, the *Hissi* would be re-dug, emptied of the sediment that had accumulated within it. The *Hissi* would then be full to the brim. Children would swim in it and animals could drink from the well without having to

[v] Serjeant records that a *Hasi* was a shallow well dug before the arrival of the floods to catch the flood waters. The collected waters were then used for irrigation. He notes that there is even a proverb linked to this: "*Man bagha 'l-maa' yaHsi luh*, He who wishes water must make a well to catch it." (Serjeant, 1995)

draw water for them[38][vi]. The arrival of the flood was therefore an event to celebrate. If no flood replenished the water table, then the family had to deepen the well, an expensive job. The removal of the sediment brought down by the flood was easier as the silts were soft and lightly packed than boring through compacted mud at the bottom of the well. Indigo dyers also used to work near the wells[39]. As the flood would raise the water levels of the wells, their job was made easier as they did not have to pull up buckets of water from so far down the well.

Festivities

H. Ingrams and H. Helfritz report celebrations on the arrival of the rains and floods. In both excerpts, the rejoicing is in anticipation of the benefits the plentiful water would bring. Parties are not specifically described, the need to make full use of the waters must have taken priority over the desire to celebrate. The extract from Helfritz is particularly interesting. He tells of the collapse of seventeen houses, an event that would be considered a disaster in the area today. The advantages brought to the agricultural sector obviously outweighed the inconvenience of the loss of a house.

H. Ingrams reported a flood in Shibam, November, 1934:

> "Then came the rain and after it the seil[vii]. The coming of the seil is a great event. All Shibam leaves its business and shuts its doors and turns out to see the turgid brown life-giving waters flood into the date gardens. In a few hours there were ten feet of water in some of the gardens outside the city walls. Everyone talked of it, everyone went to see it."[40]

Hans Helfritz describes a flood that occurred in the 1950s in Tarim:

> "As the towns there are mostly built of mud, it can be imagined what Terim looked like on the next morning. Seventeen houses were completely demolished, most of the town walls had been swept away and numerous wells blocked up. Abu Bakr's palace was a sorry sight too; streams of muddy brown water ran down the beautiful whitewashed walls and several roofs had collapsed. But these minor disasters mattered little in comparison with this rare blessing from heaven, now so lavishly bestowed. The event turned into a veritable festival. I have never known such rejoicing and happiness in an Arabian town. Everyone was outside and old and young splashed happily about in the streams pouring

[vi] Sa'iid left Shibam when he was 11 or 12, in about 1963. He used to drink and swim in the *Hissi*-s.
[vii] *seil-* pl. *seiyuul*, "flood"

through the streets. It was as though they could not get enough of this sudden excess of a vital element which was usually a meagrely rationed luxury."[41]

The dependence of the villagers and townsmen on floods for irrigation meant that their arrival was a cause of great celebration[42]. Specific songs were sung, for example, a children's song about the irrigation of their father's palm trees[43]. Young girls danced circle dances, very young boys and girls danced together[44]. The cry of *Ya Hawl Hawlaa*![viii] was shouted, not in warning, but in celebration[45]. The elderly ululated and young men fired guns[46]. People ate picnics together[47].

Even today, the inhabitants of Shibam, Seiyun and Tarim regard the floods as an exciting event, something to be celebrated, at least at first. Should the flood start to threaten their possessions and houses, celebrations would stop[48]. Nowadays, children do not sing and dance in the towns as was once traditional, although such customs still continue in the villages[49]. However, parties are still held. ʿAbdullah Bin Hashlaan from the old town of Shibam, said that residents of the old town have parties, the men fire guns into the air[ix], and they all watch the flood water rushing past[50] since the raised town of Shibam affords a spectacular view of the flooded watercourse[51]. Laylwa NaaSr, a widow from the new suburb of Jethma in Seiyun, also said that the first inclination of the community is to celebrate the arrival of the floods. She, her children and her neighbour friends have picnics outside so that they are able to watch the waters that surround them[52]. She says that it is all great fun[53].

[viii] Meaning similar to "Hurrah!, Yippee!"
[ix] Throughout Yemen, a celebration such as a wedding is frequently celebrated by the firing of guns into the air.

Co-operation and Mitigation

In the event of a flood, co-operation took place at many levels: between settlements, within the town, within the quarters, between neighbours and friends, and within the family. Such activity is crucial for the mitigation of the disastrous effects of flash flooding since it makes use of the abundant water (thereby averting famine caused by crop failure), and reduces the long-term consequences of damage to individual households and the larger community.

Between Communities

A tradition exists in the Wadi Hadhramaut and its tributary valleys of shooting into the sky to warn the villages downstream of an impending flood[54]. The warning would give people the opportunity both to remove themselves and valuable livestock from the wadi bed, and to quickly prepare the spillways and channels to the fields for the oncoming water. Jaʿafer as-Sagaaf maintained that three shots were fired if a large flood was on its way, two shots if the flood was of average size, and one shot if the flood was small*. The message carried by the gunfire would be passed down the valley like an audible series of beacon fires. Now that telephones are available in the Wadi, this practice has apparently died out[55]. However, it is postulated that villagers in Wadi Duʿaan and Shabwa still use this method of warning. I asked a man in Wadi Dhura, Shabwa, whether he and his neighbours had warned each other this way in the floods of June 1996. He said that the floods had been so loud, like a flight of aeroplanes flying over, that they would not have been able to hear the warning gunfire[56].

Within the Town

These passages from Arabia and the Isles and The Yemen; a secret journey, show that the arrival of the flood was followed by a flurry of agricultural activity. In the race to make the most of the flood waters, co-operation within the families and the larger community was very important. Irrigation channels provided water to many different families' fields, and the effective allocation of the water depended upon community co-operation[57].

* I suspect that such a system is untenable. It is more probable that the men would loose a volley as warning. A single shot might not be heard or recognised as a warning.

"As if by magic the camel park of Shibam, usually so crowded, became empty- the beduin had gone off taking their camels for ploughing. There was no transport to be had."[58]

"Everyone with a garden hurried outside the gates to divert the rivulets and streams which had formed everywhere to his trees and plants. In a matter of hours fresh greenery was sprouting on all sides in the humid tropical atmosphere."[59]

R B. Serjeant also recounts an instance of community co-operation during a flood (probably in 1954), once more taking place in the vicinity of Huraidha at the end of Wadi ʿAmd.

"When the flood-water comes down the *wadi* at night all the village turns out with lamps to work- a lively scene, especially if it be a *sail hamim*, a powerful, strong and noisy flood. ... If a man cannot get to his fields, or if he is cut off by the flood from them, or for any other reason, then those already on the spot look after the control of his water, without payment. At Huraidah co-operation in such labours is almost a duty especially when it comes to inserting the sluice plank (*sufrah*) in the openings of the fields or to removing it."[60].

He mentions that such co-operation was not unusual. The whole community would participate in the extinguishing of a house fire or the clearance of a frail man's irrigation channel during the rainy season. Similarly, if a dam or deflector weir at Huraidha was broken by the floods, a drum was beaten in the night to inform the peasants that they should bring certain tools to work the next day in order to repair the damage[61].

Co-operation was not completely altruistic. It is likely that the majority of the households in the village or town were linked through marriage and/ or trade. Should the affected household be left destitute through fire or flood damage, then the extended family was honour-bound to assist them. In particular, it was vital for the successful irrigation of fields in the same irrigation system as those of the hypothetical old man, that throughflow was effectively controlled. It was therefore to everybody's advantage that loss and damage be limited.

Quarter Relations

Prior to independence in 1967 and the subsequent rise of the Socialist Party, the Wadi Hadhramaut had a divided social structure[xi]. Nevertheless, co-operation existed between the strata. The *da'if* (weak ones): the unskilled workers, merchants, artisans and traders who were forbidden to carry arms, were protected by tribesmen and nobles[62]. Lewcock also documents that the three towns of the Wadi Hadhramaut had quarter structures in which by-laws had evolved for self-regulation[63]. This cohesion between the residents of the quarter, even amongst different classes, was of considerable importance in the event of an emergency, such as house fires, drought or flooding[64].

Reconstruction also lay within the responsibilities of the quarter. It is mentioned that poorer members of society were helped with funerals and weddings[65]. It is also likely that repairs and assistance for those afflicted by a hazard were community affairs, organised by the elected headman. In the aftermath of the *Sail as-Saba'*, traders provided assistance in kind, for example, blankets and food, to stricken members of the *Seiyuni* community. One man, in particular, is remembered for his generosity, 'Awdh Saalim BaaHabiir[66]. Apparently, at that time, the Kathiiri Sultan had no money with which to aid his people[67xii]. Although it no longer exists, the quarter system was adapted and maintained through the Socialist era. The elected Sheikh of the quarter was head of a committee; *Lijna li-difaa' as-sha'abi*, Committee for the Defence of the People. These committees were responsible if a flood destroyed a house which, in falling, blocked the road. The sheikh would organise a group of residents to clear the road[68].

[xi] The upper class consisted of the *saada* (the religious elite), and the tribal sheikhs. Tribesmen and the merchant class occupied the "middle class", "Workers in Clay" such as farmer labourers, potters and builders were of a lower class. Those whose jobs entailed dealing with refuse were of the lowest rank (Lewcock, Wadi Hadhramaut and the Walled City of Shibam: 39).

[xii] It is interesting to note that residents of the town had the capacity to act independent of the authorities. "People learn rather cynically, yet realistically, not to rely on services provided by authorities." (Blaikie *et al*, 1994: 14). As international aid often fills the gaps that lie between the coping community and the government, cultivating this independence is currently an issue amongst NGOs.

Protecting One's Own

Immediate assistance for families afflicted by floods was, and still is, provided by members of the extended family and friends. Relief can include repair work to houses, foodstuffs and accommodation. In the period of reconstruction, financial aid from family working abroad is very important.

As only local materials have been used in house construction for hundreds of years, the building materials and processes are familiar to the residents of the valley. *Madar* homeowners are particularly aware of the nature and needs of the house[69] since a *madar* house requires careful daily use and rigorous annual maintenance. This knowledge is a great advantage if the occupant has to repair his house during, or after, the flood. The simplicity and familiarity of repairs to damaged mud-brick houses means that neighbourhood co-operation is possible, and important, in the reduction of the effects of the flood[70].

> In June 1996, Fawzi Muhammed was staying in a friend's house in the village of al-Ardh, not far from Seiyun. During the rainstorms that preceded the floods, the intensity of the rain was such that he and his friend were forced to brave the storm to repair the leaking roof. For 1 ½ hours, they grabbed handfuls of the mud parapet which surrounds the flat roof and patched up the holes that were appearing beneath them. They also poked a hole in the remains of the parapet and inserted a pipe in order to drain the rainwater that was collecting on the now uneven surface of the roof.

Neighbours worked together to repair the damage inflicted on houses on the banks of SaHiil Shibam by the floods of June 1996[71]. After five days, when the flood waters had subsided in al-Ardh, Fawzi and his friend helped their neighbours to repair their houses[72]. They also repaired, with mud and rocks, the foundations of the friend's second house which had been undermined by the floods.

Major repairs are tackled after the house is completely dry again, which is sometimes up to a month after the flood[73]. Such repairs can be executed by the community or by local builders. The post-flood and rain period of repair and reconstruction is a prosperous time for all those involved in the building trade (*madar* makers, builders, *nuura* workers) as a considerable amount of work is passed on to the builders.

Should a house be destroyed or badly damaged by the floods, the homeless household stay with family or friends[74]. (I give here an example of a *Shabwaani* family made homeless by the 1996 floods. The generosity afforded to them by their family is the likely response of a *Hadhrami* family in an equivalent situation.)

> Once the floods has subsided, the Taahir family (Shabwa) went to stay with neighbours whose houses had been untouched by the floods. They stayed with them for about two weeks until an aeroplane flew to the NiSSaab area to distribute tents and foodstuffs. The Taahir family received a tent and erected it in the yard of their ruined house. Half the family (about ten members) stayed in the tent, the rest went to live with some close relations in a nearby village. They stayed with the relations for 6 months, until the cement house had been repaired. They paid no rent and they were asked for none. Family obligations are stronger than financial considerations[75].

Although the tents issued by the Red Crescent after the floods of 1989 and 1996 were suitable for beduin and families in distant valleys (such as the Taahir family), the provision of tents for homeless families was unpopular in urban areas of the Wadi Hadhramaut[76]. The tents could accommodate only a few members of the family and offered very limited levels of privacy. In the urban context, tents are overlooked by neighbouring houses, and street life interferes with family life. In isolated villages, the practicalities of sanitation are not an issue for it is easy to slink off to an isolated spot. This is not possible within a town. Newly-homeless *Hadhaarim* preferred to stay with relatives, and the tents were used as shelters for the guards at checkpoints.

Remittance Money

The availability of remittances are extremely important to a family attempting to reconstruct their lives after a flood. The availability of amounts of foreign currency, that can be exchanged at favourable rates, is very important in the rapid reconstruction of homes and re-establishment of livelihoods. In the aftermath of a disaster, a family with financial backing can use accumulated and donated capital to repair damage and replace goods. During the period of reconstruction, money can buy "virtual time": a wealthy family can use money to pay builders while they can go back to work.

Many of the families in the Hadhramaut have family members working in the Gulf or Saudi Arabia, and still have branches of the family in East Africa or Asia[77][xiii]. It is estimated that a large proportion of *Hadhaarim* are in receipt of remittance money, or could have access to it in the event of a disaster. In general, families with relations in East Africa have less money than those with family members in Indonesia or the Gulf[78]. Kenya, Uganda and Tanzania lack the trading opportunities of the stable, wealthy economies of the Gulf and East Asia. Although many Yemeni workers were forced out of the Saudi Arabia following the Gulf War[79], there are large and unquantifiable numbers of Yemenis, particularly *Hadhaarim*, who bear Saudi passports and were not expelled.

Taalib ATTas, a money changer in Seiyun said that, in the event of a disaster, money will come flowing into the governorate[80]. This was backed up by the deputy of the *Mudiriyya*, Abu Bakr al-Haamid. Money is sent within families, not to the community as a whole[81]. Inevitably, some families are helped by no-one[82]. Often a video of the effects of the flood is sent to family abroad, this is passed around the Yemeni expatriate community[83]. Days after the floods of 1996, money, in the form of draft cheques, came pouring in from emigrants in the Gulf to Shabwa, many of whom were responding to a video of the disaster[84]. Cash still is brought across the border[85], but most transfers are now done by telephone through the money-changing agencies[86] available in each town, especially in Seiyun. Expatriates instruct one of the agencies to forward a certain amount of money to a particular person. The agent in the Hadhramaut then waits for the recipient to pick up his money. The money usually takes two or three days to be processed[87]. The recent acceleration of the system, through the use of telephones and videos, means an important reduction in the vulnerability of the inhabitants of the towns. The time-scale is important because the longer a family or community is left without the ability to earn money, the longer the effects of the hazard will continue.

[xiii] Many of the men to whom I spoke had relatives working abroad. Even though a family might receive returns on property in Asia, many have members working in the Gulf or Saudi Arabia too. Manaaf ʿAboud's grandfather worked in Indonesia. His father worked in Saudi Arabia for many years but is now back in the Wadi Hadhramaut. AHmed al-Kaaf's brother is a trader in Saudi Arabia and has a Saudi passport. Although it is a hard and long working day (7 am- 2, 4- 11 p.m.), the money is good and he is able to send money back to the Hadhramaut (AHmed al-Kaaf, 8/5/97). All the BaaHashwaan family who work in Saudi Arabia, sell gold. There is also a member of the family who makes famous wedding-quality sarongs in Indonesia (Hassan BaaHashwaan, 6/5/97). AHmed BaaKulka is a shipping, cargo and travel agent in Jedda. He also owns a wedding complex and rents out four houses. He owns significant amounts of land in Seiyun (AHmed BaaKulka, 22/5/97) and maintains strong links with family in his home village in Wadi Duʿaan.

Through the co-operation of different sections of the community, the levels of vulnerability of Shibam, Seiyun and Tarim to the hazard of flash flooding are reduced. These structures frequently have their roots in agricultural practices although the consequences of their implementation affect the towns around and in which they were (and are, to a diminishing extent) practised. The continued execution of repair work and other preventative and mitigative activities is largely dependant on the level of importance of agriculture in the area. Unfortunately, as we shall see in the subsequent chapters, there has been considerable disruption to the traditions associated with flooding. This has been caused by the rapid rate of urbanisation in the Wadi Hadhramaut, and a corresponding decline in the agricultural sector. The process of urbanisation is traced in chapter 7.

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[79] Abu Bakr Saalim al-Haamid, 14/5/97
[80] Taalib ATTaaS, 8/5/97
[81] Abu Bakr Saalim al-Haamid, 14/5/97, Atheer SalaaH ad-Diin Najm, 21/3/97
[82] Atheer SalaaH ad-Diin Najm, 21/3/97
[83] Atheer SalaaH ad-Diin Najm, 21/3/97
[84] Atheer SalaaH ad-Diin Najm, 21/3/97
[85] Abu Bakr Saalim al-Haamid, 14/5/97
[86] Abu Bakr Saalim al-Haamid, 14/5/97
[87] Abu Bakr Saalim al-Haamid, 14/5/97

Chapter 7

Urbanisation

Having shown that the hazard of flash flooding has been contained through careful town planning, and mitigated through local knowledge, community cooperation and preventative building techniques, this chapter is the turning point. It is only on the rapid and indiscriminate expansion of the three towns that flash flooding has begun to pose more of a threat. The control of the urbanisation process is key in the reduction of vulnerability. The process should be well-planned and gradual, enabling the housing needs to grow in parallel to population changes in the community. If available land is planned and allocated in one short period then the chance to develop zones and ration the land is limited, since houses should be constructed in proven safe areas. If urbanisation occurs slowly then the impact on the environment can be gauged and time is available for studies into flood protection works and wadi discharge rates to be completed.

Unfortunately, over the last twenty-five years, the process of urbanisation in the three towns in the Wadi Hadhramaut has been erratic. This process can be separated into three stages. On the departure of the British in 1967, the new leaders of the country attempted to address the immediate housing needs of the country by nationalising and redistributing houses once occupied by expatriates. This procedure was followed by further requisitions country-wide of houses not occupied by the owners. Such sweeping confiscation, coupled with restrictive investment laws[1], heavily discouraged private investment in the housing sector. The housing crisis continued in much of the country throughout the 1970s. However, by the late 1970s, towns in the Wadi Hadhramaut were swiftly expanding. Recent changes in policy allowed for the investment of large amounts of remittance money sent from the flourishing new oil states of Saudi Arabia and the Gulf by Yemeni migrant workers. Following the Unification of the two Yemens in May 1990, and the re-introduction of capitalist ethos to the southern states, the towns again experienced rapid growth. Urbanisation in this third stage was augmented by a Presidential Decision taken in 1990 which aimed to compensate house-owners whose houses had been requisitioned in 1972; where possible, houses were returned to their original owners and the tenants who had occupied the houses for 20 years or more were forced to leave. In order to house the newly-

homeless, former tenants were given two plots of land so that they could finance the construction of a new house. One plot was to be sold, the other was to build upon. The sudden freedom in the land market has brought about an unprecedented explosion in the numbers of houses being built.

In order to be able to chart the growth of the towns, it is important to estimate the number of people who live in the towns. This, unfortunately, is not easily achieved. Tables 5-8 chart the population rise in the three main towns of the Wadi Hadhramaut and of the whole Governorate of Hadhramaut. I acknowledge that there are major discrepancies in the tables caused by the compilation of estimates from different sources, each of which were affected by the many problems involved in the assessment of population growth in the region. There were no separate censuses taken for the towns of Tarim and Shibam during the Socialist period[2]. There are few computers in the area for instant data input. The scarcity of private telephones mean that random households cannot easily be contacted to ask how many people reside in the house. The calculation of the average number of people per household is made more complex as many of the homes house extended families[3]. Families who have migrated to the oil states often retain the family home. Rural branches of the family often visit the town-dwelling members, sometimes for many months. Migrant workers in the Gulf and Saudi Arabia cross the border frequently as they maintain close contact with their family. Such fluctuations in the local population increase the scope of error in the estimates. Finally, a town can have expanded physically while the numbers of inhabitants remained relatively stable. This is certainly the case at present as many people are taking advantage of the opportunity to buy and build on cheap land. Suffice it to say, the populations of the towns in the Hadhramaut have indeed grown rapidly since 1973, in keeping with the high birth-rate of the country.

year	n° of buildings	n° of households	total population	Source
1973	3000	3100	19200	[4i]
1977	7000	2300	16950	[5]
1988			22100	[6]
1994	4300	4000	34600	[7]

Table 5: Population of Seiyun, 1973 - 1994

year	villages	n° of buildings	n° of households	total population	Source
1973 district inc. town	36	4300	5300	28600	[8]
1977 town only		900	500	3300	[9]
1986, old Shibam				7000 + [ii]	[10]
1988 town				3300	[11]
1994		1050	1000	6700	[12]

Table 6: Population of Shibam, 1973 -1994

[i] Figures all rounded up or down to the nearest 100.

[ii] In 1986, R. Lewcock wrote that the population of the old city of Shibam was greater than in the previous century although the number of houses had not increased. The reason for this was the subdivision of the tower houses after the Housing Law of 1972 (Lewcock, 1986).

year	villages	n° of buildings	n° of households	total population	Source
1973 district inc. town	30	6300	7500	42900	[13]
1977		5900	2100	6300	[14]
1988				14300	[15]
1994		2110	2407	17065	[16]
1995		3129	3246	24631	[17]
1996				87 000	[18]

Table 7: Population of Tarim, 1973 -1996

year	population urban	population rural	total population	n° of families	n° of houses	source
1973			491300			[19]
April 1988			703200			[20]
88/86	173500	363600	537100			[21]
88/86			626300			[22]
Dec. 1994			870000			[23]
1994			716500 residents	105600	99700	[24]
1996		479700	718000			[25]

Table 8: Population of the Governorate of Hadhramaut, 1973 - 1996.

Before Independence in 1967

Early expansion in Seiyun and Tarim extended the old city on the high ground beneath the mountains, and began the occupation of the islands on the land in between the channel/ roads. Beneath the mountains, development was the traditional close-packed harmony of alleys and tall houses. In the 1930s, W H. Ingrams reported that Seiyun was a walled town of more than 1,500 houses. Even during that period, the town was expanding east across the alluvial fan of the valley[26]. Tarim was also experiencing growth although the 2000 houses were still within the town wall[27]. The islands between the networks of water channels that disperse flood flow attracted the development of a grand villa-style house, extending horizontally within spacious gardens. These properties were originally summer houses of the rich, built in the shady isolation of their palm groves. They were, however, to be followed by other developers, keen to escape the increasing crush of the old town, and equally attracted by the environment and scope for horizontal expansion that the area offered. Shibam too began the development of the suburb of SaHiil and became a sandwich city: two slices of settlement on either side of a major watercourse.

Construction was funded by remittance money brought or sent into the country by the large expatriate *Hadhrami* community. The Hadhramaut has a history of migration which started over a thousand years ago to East Africa. Generations of *Hadhaarim* have also emigrated to India (C13th), Indonesia (C16th), and Singapore (C19th). In the 1930s, Ingrams estimated that about 90,000 to 100,000 *Hadhaarim* were living abroad[28]. The expansion of Tarim in the 1920s- 1950s was characterised by the construction of massive mud-brick palaces which drew on a rich combination of architectural styles, among them Moghul and classical. Most of these glorious palaces were built by members of the al-Kaaf family with remittance money sent back from, and to styles that were in vogue in, Singapore.

1970s: Housing Crisis

At the time of independence, Shibam, Seiyun and Tarim were very wealthy towns, still relying heavily on money remitted from the East Indies and East Africa[29]. In contrast, by the 1960s the rest of the country was afflicted by a housing crisis. A series of housing laws in the late 1960s and early 1970s sought to address the situation by rectifying the problems of inadequate shelter and the inequality of housing distribution. Unfortunately, independence from the British and the resulting loss of financial assistance, limited the government in what they could achieve. Many issues needed to be addressed with only limited resources, the construction of housing did not take priority[30]. In 1967, houses that had been inhabited by British expatriates were nationalised and redistributed, mainly to government employees[31]. Another law quickly followed which permitted the government to let houses if they had been left uninhabited for three months[32].

The third Housing Law, n° 32 was passed on the 5th August 1972[33], in which the government requisitioned all housing units except for those dwelt in by their owners[iii][34]. Force was sometimes used to evict the owners[35]. Nationalisation was mostly limited to urban areas[36]; of about 70,000 housing units in ʿAden, 59,750 were nationalised[37]. The law gave every citizen the right to one residence, and gave no more than YD 50 per month to citizens whose sole income had been the houses he had let before nationalisation[38].

The law liberated housing units in urban areas that the government could rent out at a 25% reduction in rates. The private rental market was effectively abolished as the government took all private investments in the housing sector[39]. Large family houses were often divided into flats. The original family stayed in one section, tenants rented the other[40]. In Shibam, 150 skyscraper houses were requisitioned and rented to tenants at a token rate[41]. For example, a six or seven storey house would be let for one or two dinars per month, between £2 and £4[42]. If a house was shared by more than one household within the extended family, the rent paid would be even less as each household contributed to the rent[43]. Rent in the smaller houses of Seiyun was one dinar per month[iv]. Requisitioned houses were let to rural

[iii] Trading establishments were also nationalised, as were *waqf* (belonging to the mosque) possessions and houses belonging to local companies and institutions (ʿAbdullah bin Hashlaan, 8/3/97, PDRY Embassy, (1977).

[iv] During the Socialist period, one dinar could buy 3 kilos of *lakhm* (dried shark), one kilo of meat, or one large can of powdered milk (Huud Bal-Khayr, 21/5/97).

to urban migrants, tenants of the old rental market, friends of the Party, and poor people. A contract of occupancy, an *'Agd Intifaa'*- contract of benefit, was given to the new inhabitants by the Party.

The cheap rent on requisitioned houses and the advantages of living in a town in terms of services and job opportunities, enouraged rural to urban migration, particularly as the nationalisation of housing units had barely affected the majority of the rural population of the PDRY[44]. Huud Bal-Khayr estimated that, about 70% of those who lived in government rented accomodation in Seiyun came from rural areas of the Wadi Hadhramaut network[4546]. He also suggested that rural to urban migration was encouraged by a slight land allocation bias towards the rural migrants on the part of the government[47], these people coming under the category of *ta'abaan*: impoverished, incapable of helping yourself, perhaps slightly stupid[48]. Towns became increasingly crowded and the pressure on the rented accommodation became more pronounced. By the mid-eighties, the public rental market was crowded. Once a demand for a house had been written, a family would have to wait one or two years for a house to become available[49].

Construction Curtailed

The 1972 Housing Law was a major obstacle to healthy town expansion. It effectively froze the house construction despite the continued population growth and rural to urban migration[50]. Not only was the government financially incapable of constructing houses for the growing urban population, private investment in the property market had been effectively and deliberately curtailed by the 1972 Law.

On the requisition of the houses, the government took on the responsibility of house construction, maintenance and provision[51] under the authority of the newly-created Ministry of Housing[52]. Unfortunately, as rent returns were so low, the government was unable to either repair or maintain with any regularity the houses for which it was responsible. Neither was the government able to build many new houses once the population exceeded the capacity of the requisitioned houses. With its limited resources, the government gave priority to development projects and office buildings rather than residential housing[53]. The low priority given by the authorities to private housing is demonstrated by the attitude of the Governor of the Fifth Governorate (Hadhramaut): "During 1977, the Governor of the Fifth governorate (which had a considerable emigrant population) stopped all work on

private housing in order to achieve Government/ public sector construction targets."[54]. The result was that, between 1973 and 1979, fewer than 1,500 flats or houses had been built by the public sector country-wide[55]. On average, the annual public investment in house construction during the period covered by the First Five Year Plan (1974-1978) was less than one million dinars [56]for the whole country.

The Housing Law of 1972 had adverse effects on private sector investment in housing. In 1979 and 1980, the private expenditure on housing was YD 1.5 million and 3 million respectively[57]. During the 1970s, it was illegal for houses to be constructed for rental purposes, and there was no incentive to do so since the Party had severely undercut rent rates. This period was also marked by uncertainty, reflected in the construction of smaller houses. A larger house was more expensive to build and potentially threatened by division and requisition[58]. The expectation that the government would requisition any investment in housing artificially restrained private investment in the Wadi Hadhramaut[59]. So did the uniformly low wages of the new regime, few could afford the cost of house construction. Although large amounts of money were being earned in the Gulf States and Saudi Arabia, the threat of taxation discouraged its remittance[60]. It was therefore cheaper and easier to rent a house from the Party than to build one's own house.

Late 1970s - 1980s: Rapid Expansion

Public sector investment in the early 1970s had centred exclusively on urban areas, particularly in the capital, ʿAden[61]. In 1981, it was reported that the majority of people in areas outside ʿAden still lacked adequate housing or utilities[62], indicating that the Socialist policy for the housing crisis had failed, even in the short-term. The demand for housing was exacerbated by the persistent lack of maintenance on government housing which led to the abandonment and collapse of many houses. During the 1980s, many poorly-maintained houses started to collapse[v], increasing the crush on the remaining houses and necessitating the construction of a new house either on the spot or in a new area. Frequently tenants or owners of a badly-damaged house in Shibam would move to the suburb of SaHiil to build rather than reconstruct in Shibam town[63].

[v] Those that are still standing are in poor condition. Shibam in particular has suffered from this problem (ʿOmar AHmed Saʿaidaan, 4/3/97).

To address the continued housing crisis, the government set new objectives for the Second Five Year Plan (1979 - 1983). It was proposed that YD 86.3 million would be laid aside for housing[64], and a target to build 5,900 apartments in the following five years was set[65]. Even so, most of the planned housing units (5,370) were to be built in 'Aden, only 102 units were planned for the Hadhramaut[66]. So, recognising that the only long-term answer to the housing situation in the hinterland was private investment in housing, the government turned towards the previously ignored resource of remittance money[67]. In 1978, the Government decided to encourage the construction of private housing by giving Yemenis working abroad a free plot of land so that they could build houses for their families back in PDRY.[68]. The government sought to take advantage of the rising wage levels[vi] in the oil states by offering high-interest bank accounts for non-residents, liberalising own exchange imports, and permitting some flexibility in the numbers of people allowed to migrate, the levels of which had been capped since 1974[69].

The release of the grip the Socialists had maintained on town expansion through restrictions on house construction had dramatic results. Whereas between 1973 and 1979, private investment throughout the country in house construction was less than an average of YD 1 million each year[70], in 1980 over 10% of estimated remittances, that is YD 14 million, was spent on housing[71]. The inhabitants of the Wadi Hadhramaut seized the opportunity[72]. "Most of the private housing construction is in the Fifth Governorate (Wadi Hadhramaut area), from which a large number of people are working abroad.[73].

Not everyone, however, was able to take advantage of the apparent freedom to build. Under Socialist policy, "each citizen is entitled by the land tenure law to own a piece of land, for building his house, at an officially controlled cost set within the inhabitants' financial means."[74]. The sale of land to members of the public was controlled by the state since the Party had also requisitioned most private land in 1972[vii]. Although it was possible to own a piece of land, it was not necessarily very easy to purchase one. Allocation of government plots was slow, unless you had a Party card[75]. The combination of a lack of movement in the construction sector followed by a boom period had also led to extremely high costs in house

[vi] Amounts of remittance money are difficult to assess. During the Socialist period, lots of money was carried in cash across the border from the Gulf and Saudi Arabia in order to avoid the tax imposed upon remittances (Abu Bakr Saalim al-Haamid,14/5/97). Estimated remittances in 1974: $41 million, in 1978: $258 million (The World Bank, Report n°. 2683-YDR. (1980). Estimated remittances in 1973: YD 12 million and 1979: YD 108 million (UN, 1981).

[vii] The Agrarian Reform Law was passed in 1968 but not implemented in the Wadi Hadhramaut until 1972, the same year as housing requisition. A bad year.

construction. The increasing number of emigrants returning and commissioning houses could not be matched by the craftsmen and builders[76]. Between 1970 and 1980, it is estimated that construction costs increased by twenty times[77].

1990 - Today

On unification with the tribal capitalist north, and the slide into oblivion of the Socialist ideology at the end of the Cold War in 1989, restrictions on land sales and house construction were lifted. Most of the construction in the Wadi Hadhramaut that has occurred since Unification has taken place in the towns, particularly in Seiyun[78]. The rapidity of the expansion has been exacerbated by a decision taken by the new government, a coalition of the northern *Mu'tammar* party and the Socialist party, to return confiscated land and property and to compensate the newly-evicted tenants[viii]. The subsequent abundance of cheap land on the free market has caused massive expansion of new suburbs in Seiyun, Tarim and Shibam.

In 1990, a Presidential Decision was taken, resolving to return confiscated lands and property to the original owners[79]. The government then faced the prospect of a legal crisis as well as another housing crisis as they had to address the situation of the former tenants who had documents (the *'Agd Intifaa')* from the previous government permitting them to reside in the houses[80]. Many of the people who had lived in rented accommodation were from the poorer levels of society, for example the *'abiid* class[ix][81] and rural to urban migrants. Few had sufficient savings with which to buy land of their own and build a house.

A plan was formulated giving two plots of land as compensation to the ex-tenants, enabling them to sell one plot and with the money build on the other. Originally 1100 -1200 plots of land were laid out for the ex-tenants[82], enough for 550- 560 families for which the families had to present their *'Agd Intifaa'*. By May 1997, about 690 families had been given a pair of plots, another 90 families had been given single plots[83]. This land was given completely free[84]. Two years of leeway were given to the ex-tenants to move out of their previous accommodation and build their own house[85]. All inhabitants in the Wadi Hadhramaut agreed to relinquish their houses, albeit under pressure from the government who cut electricity and

[viii] The Socialist party had initially wished to sell the houses back to the original owners[viii].
[ix] Originally the slave class.

water supplies if they refused[86]. If a family desired to stay in the house that they had occupied for almost twenty years, they had to agree a rent with the original owners of the house[87]. No compensation was given to the original owners whose houses had been destroyed or irreparably damaged by the lack of maintenance under the old regime[88].

Following the allocation of plots, there was a glut of cheap land on the market. As intended, former tenants sold one of their plots in order to make the money necessary to build on the other. The market was further saturated with land as the government sold off large areas of wasteland on the edges of the towns. This land was also sold for low prices since, at the time, the areas were less desirable because they are slightly out of town, and there was apparently so much available[89]. Private land was also sold, although at higher prices because it is usually nearer the town centre[90].

> ʿAli Saʿiid Shamaakh was given two plots of land in Jethma on presentation of his contract, and sold them shortly afterwards in 1993. He exchanged one plot for a Toyota Cressida car, the other he sold for 200,000 shillings[91]. He said he could now sell the plots of land for a million riyals each[92].
>
> SulTaana and her family also received two plots of land in Jethma which were both sold for 300,000 yr.. These plots could now sell for one million riyals each[93]. They then bought another in ShuHuH for just 7,000 yr.[94].
>
> Hassan Baahashwaan bought his plot of land in the quarter of Hayy al-WiHda from a man who wished to sell his second plot of land. He spent 13,000 yr. for the plot, including the completed licensing and planning[95].

With the ample availability of land on the market, the construction of houses for investment and accommodation was suddenly legally and financially feasible. No longer were there restrictions on who could build, the government sells to all sections of society[96]. Many migrants from rural areas are taking advantage of the cheap land, particularly as services in the towns are still not matched by developments in the villages[97]. A backlog of families who could not afford to build a house during the Socialist era are now moving into their own new homes[98].

Exacerbating Factors

Other factors have also exacerbated the rapidity of urbanisation in the Wadi Hadhramaut since 1990.

The Gulf War of 1991 had an effect on the proliferation of house construction in the Wadi Hadhramaut. *Hadhrami* workers in Saudi Arabia and elsewhere in the Gulf saw the Kuwait *Hadhrami* expatriate community lose everything in the Iraqi invasion. In response to the uncertainty of their future, many sent money back to Yemen so that their families could build houses on their behalf in case they were evicted. Some were indeed forced out of Saudi Arabia during and after the war[99].

The rate of urbanisation has been accelerated with profligate grants of lands by the State. Plots of land have become the government's currency. This seems to have also been a Socialist practice, demonstrated by the government's free land incentive to migrant workers in 1978[100]. Currently under construction is a new road from Seiyun to al-Mukalla. The executor of the government-run project has been rewarded with 40 plots of land near the pass[101]. Apparently, it is also common practice for the local government to sell plots if it has not enough money for small projects[102]. The new cobbled extension to Algeria St. (in progress, May 1997), was funded by selling land in Jethma. The Department of Culture has been given a plot of land and permission to build a new department in Jethma. The enclosed document (figure 9) is a copy of the certificate of ownership given to the Head of the Department of Culture. At present, the Department is located in the vast palace that dominates the centre of Seiyun. There is plenty of space for the Department. In fact, most of the rooms of the palace are not in use. Unfortunately, the *madar* palace is in urgent need of repair and the money to do so is unavailable[103].

There has been a consistent lack of town planning expertise in the Office of Housing and Town Planning. Unfortunately, unskilled planning is a poor base for further planning, particularly if it too is unskilled and proceeds at an unprecedented pace[104]. In 1983, there were only two qualified Yemeni town planners in the whole country[105]. Neither of these men were based permanently in the Wadi Hadhramaut[106]. In Seiyun, there is no master plan for the development of the town comprising residential and business zones, the pressure at the moment is for housing space rather than industrial and trading establishments. In the recent construction spree, the town planning department of the Housing Office has not felt

بسم الله الرحمن الرحيم

الجمهورية اليمنية

مكتب مصلحة أراضي وعقارات الدولة

م / حضرموت / سيئون

التاريخ: ١٥/ ٣ / ٩٧م

الرقم ٥٤٩/ ٥ / ٧ / ٩٦

الموضوع : منح قطعة أرض لمكتب الثقافة م / سيئون

بناءاً على توجيهات : مدير عام مديرية سيئون رقم ٢٣ / ج / ٩٦

أتفق كل من مدير مصلحة أراضي وعقارات الدولة م / حضرموت / سيئون كطرف اول .

والأخ / مدير إدارة الثقافة م / سيئون كطرف ثاني .

وبناء على طلب الطرف الثاني قطعة أرض لغرض بناء (مكتب لإدارة الثقافة)

فقد حددت للطرف الثاني قطعة أرض في مخطط (الجثمة الحكومية) رقم القطعة (٤) ع / ٩٢

حسب الابعاد التالية : .

الإبعــاد : ١٥ × ٢٥ متر . شرق وغرب ١٥ م ، شمال وجنوب ٢٥ م

المساحة : ٣٧٥ متر مربع . ثلاثمائة وخمسة وسبعين متر مربع

الحدود :

غرباً / شارع ثم قطعة رقم ٨ شرقاً / فضاء ثم المسجد

شمالاً / شارع ٣٠ متر جنوباً / ملاصق للقطعة رقم ٣

وعلى الطرف الثاني البدء بعمل التصاميم للموقع واستخراج رخصة البناء وفي حالة إخلال الطرف الثاني بعدم البناء أو تغيير الاستخدام الذي من أجله سلمت للطرف الثاني الارض غير الذي أتفق عليه فيحق للطرف الاول إلغاء هذا الاتفاق وسحب الارض دون أي قيد أو شرط.

الطــرف الاول / مهندس / عبد الله علوي الكاف مدير مكتب مصلحة اراضي وعقارات الدولة / سيئون .

الطرف الثاني / الأخ / مدير إدارة الثقافة م / سيئون / هناف عبد [illegible]

التوزيع مع التحية :

مدير عام مكتب الانشاءات والاسكان والتخطيط الحضري م / ح . سيئون

الملف .

Fig. 9. Document of ownership for land in the suburb of Jethma

able to curb licencing until a comprehensive town plan has been designed. Each patch of available land has been worked on independently in simple grid form[107]. All the suburbs in Seiyun, Tarim and Shibam have been blocked out in this manner[108]. In Tarim, those responsible for town planning have not studied the subject. According to Hafiidh Sabii', their method of town planning was as simple as drawing a grid of horizontal and vertical lines[109x].

In the 1930s, a trend started in all three towns for modern houses for villas that extend horizontally rather than vertically. It is still a popular style. Unfortunately, these houses take up much more land than the more traditional tower houses, particularly as people also like to have a garden around their house. As urbanisation has taken place quickly, the limited land available is still allocated and bought in patches that will accommodate these large houses. This is a shame for the role of the tower house could have been important in the reduction of vulnerability through the efficient use of land. If urbanisation had taken place over a longer period of time, a return in the trend for tower houses could have been encouraged by restrictions on plot and house sizes.

Expansion and Land Shortage

The consequent pressure exerted on the available land is indicated by the recent rapid increase in land prices in the three towns[110]. In Seiyun, there are no more large patches of land to plan and sell. Only individual plots exist in the main body of the town[111]. SaHiil Shibam is close to completion, so too are the raised areas of land in Tarim.

Since Unification in 1990, most of the construction activity in the Wadi Hadhramaut has taken place in Seiyun. Over the last 15 years, areas once considered far from the city have become central. About fourteen years ago, Huud 'A. Bal-Khayr built a house on the mountain side towards the end of Algeria St, then on the outskirts of Seiyun. His house is now thought to be close to the town centre[112]. Even in 1981, few houses had been constructed to the north and on the link road to the airport[113]. The new quarter of Hayy at-taHaalif, on the mountain

[x] Most of the planning for the modern-day expansion of Seiyun was drawn out in two periods: 1990/ 1991, directly after Unification and 1994/ 1995, after the Civil War. All the planning for the suburbs was achieved during the first period. 'A al-B BaaRaJaa' estimated that the numbers of plots drawn up amounted to more than 12,000. He said that the majority of the plots, about 8- 9,000, were plotted during the latter period. About 5,000 were drafted in 1990/ 1991. Unfortunately, detailed and organised records were inaccessible, if they indeed exist. ('A al-B BaaRaJaa', 23/5/97).

side far up Wadi Jethma, used to be the distant, wilderness spot for Friday picnics and illicit boozing sessions[114]. Today, these areas are fully integrated into the town.

Seiyun has also expanded with the development of suburbs in neighbouring minor wadis and further up Wadi Jethma (see plate 5). The closest new development to the town centre is Jethma. This area is the triangular plot located just below the Muz'aan, between the beginning of the channels that lead to Guesthouse Road and Algeria Street (See enclosed plan of the area, figure 10). In 1988, Jethma was wasteland, no houses had been built past the hospital[115]. It was in Jethma that the majority of the plots for compensation scheme were allocated. Consequently, since Unification, a few hundred houses have been built in Jethma. The neighbouring villages of Tariis and Ghurfa are also gradually becoming suburbs of Seiyun[116].

Emphasising the need to make more land available for construction, a proposal has recently been suggested for the construction of a new suburb upon the *Jol* when the new road to al-Mukalla has been completed[117]. The plan has not yet progressed from fantasy to fact since the problematic design of utilities such as drinking water, sewerage and electricity has so far proved insurmountable. This is just as well, for the implications of the settlement upon the town need to be studied thoroughly, particularly with regard to runoff and flash flooding. If urbanisation in the wadi causes flash flooding to increase in severity, then development on the *Jol*, where most of the rain falls, is likely to intensify the potential for disastrous flooding.

Tarim has developed in a similar manner to Seiyun, starting on the high ground and working slowly down to the wadis. Only in the 1970s were houses first constructed outside the town walls of Tarim. Immediately after the Socialist took power in 1968, sections of the town wall were deliberately and symbolically torn down by inhabitants[118]. Expansion in Tarim has taken place along the banks of the main channel for Wadi 'Aidiid, in the quarters of ath-Thawra and October[119].

The number of houses in the old town of Shibam has remained fairly constant for centuries, restricted for geographical and defence purposes by the walls surrounding the hillock on which the town is built. Expansion has therefore taken place in SaHiil. Various factors have also encouraged expansion in SaHiil, most of them financial. The money needed to build one seven-storey *Shibaami* skyscraper in 1987 could build three or four houses in SaHiil of one or two storeys[120]. Shibam SaHiil has almost reached its capacity[121].

Plate 5. From the roof of the Sultan's palace, looking up Wadi Jethma: The expansion of Seiyun across the alluvial fan.

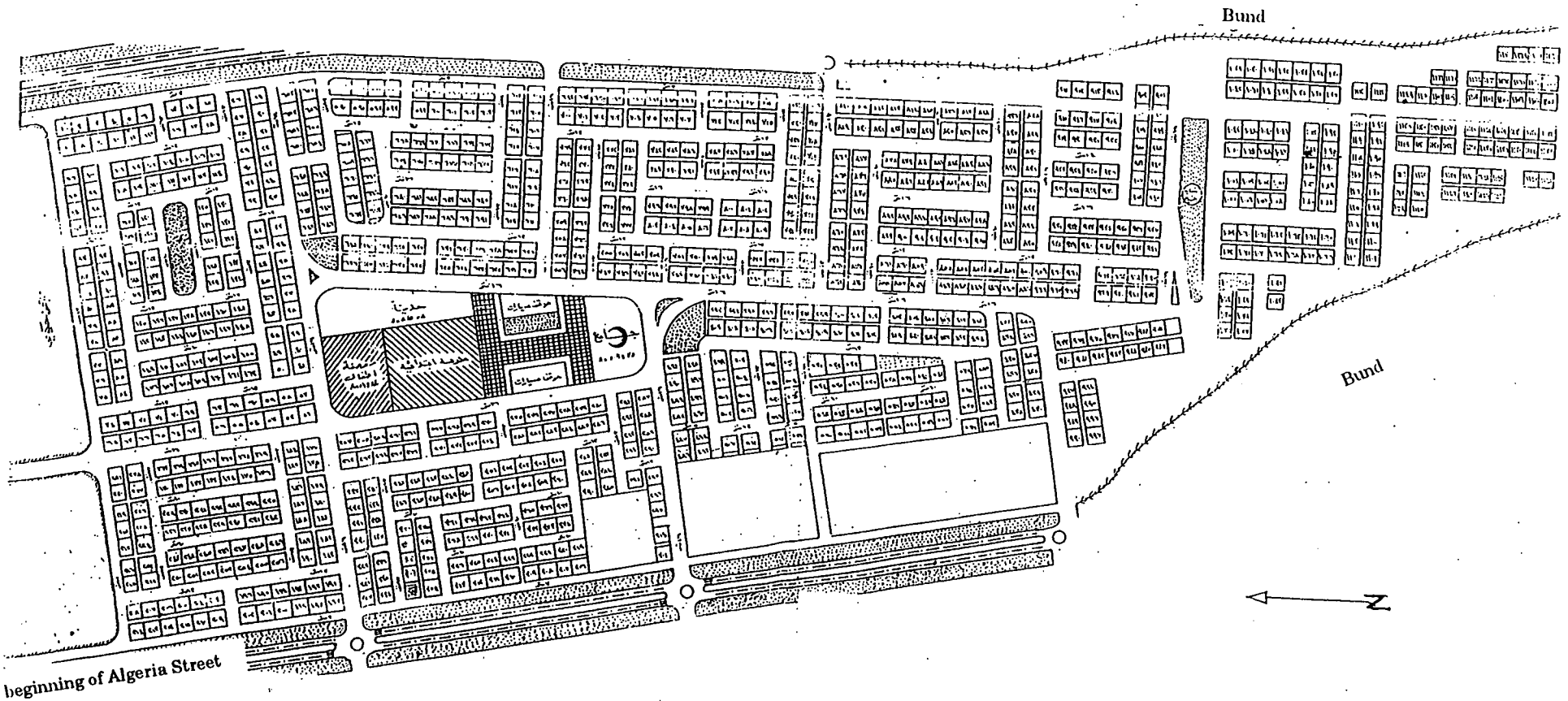

Fig. 10. Plan for the suburb of Jethma.

Source: unavailable. The plan was secretly copied for me.

one house plot = 15m by 25m

The Presidential Decision of 1990, designed to compensate former tenants of the state, has had serious side-effects on the rate of urbanisation. As a result of the sudden availability of land, the last stage of urbanisation has been the most extensive and the most rapid. The implications of stifling and then releasing the housing sector in this way will be felt in the long-term rather than in the short-term. However, already the limited land underneath the mountains and between the channels of the flood dispersal network has been used to the full, there remain few options for expansion near the centre of the towns. The consequence of the land shortage has been the steady encroachment of the watercourses and the development of the palm groves and fields within and on the edge of the towns. Construction in these areas threatens the houses that are built within them and disrupts the diversion and dispersal network that protects the towns.

In charting the growth of the three towns through the years since 1968, it is obvious that the towns of the Wadi Hadhramaut have grown considerably. As has been shown, Seiyun, Tarim and Shibam have been subject to rapid expansion, particularly since Unification in 1990. It is obvious that one bad policy (1972) has been followed by an equally bad decision (1990) allowing the process of urbanisation to burst forth in an uncontrolled rush. The irregularity of the process of urbanisation in the Wadi Hadhramaut, and the extent of house construction in the past seven years have made the principles of building on raised ground and controlling flood waters in lower areas difficult to maintain. The favoured high ground is limited to the mere edges of the wadis and the islands of land between the channels, insufficient to accommodate the housing desires of the inhabitants of the towns. The consequences of this most recent construction boom are therefore very important. As land near the base of the mountains is rapidly being filled, areas closer to the watercourses and agricultural land have come under the eye of the developer. The issues relating to the consequences of urbanisation shall be discussed in the following chapter.

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Chapter 8

The Consequences of Expansion

Housing a rapidly expanding population demands careful management in a hazard-prone environment. It is obvious that the denser the population in an area susceptible to flash flooding, the greater the potential for disaster. As there are now more people, more businesses and infrastructure in the Wadi Hadhramaut than in the past, any increase in vulnerability through poor planning has augmented consequences. It is essential for the future safety of the three towns that the fine balance between flood prevention and mitigation systems and urbanisation is maintained. Careful management of land allocation is important to keep the vulnerability of a growing population at a minimum. Lamentably, urban expansion in Seiyun, Shibam and Tarim has begun to threaten the efficacy of the diversion and dispersal networks by creeping construction on the edge of flood channels and the development of fields and palm groves into areas of housing. Damage to the dispersal networks has been further compounded by a consistent lack of maintenance to the stone and mud structures within the systems which guide and disperse the floods. Not only are houses within the towns at risk because of their construction near existing channels, so are new developments in the suburbs. As Seiyun has been subject to greater expansion than Tarim and Shibam, it therefore dominates my discussion. It is, however, to Tarim and Shibam that I turn for case studies on the effects of flash flooding on densely-constructed areas.

The Continued Importance of the Dispersal Systems

Alluvial fans, such as those upon which Seiyun and Tarim are built, are hazardous areas for town development. "Because of the variability of flow regimes and the variable nature of the material comprising the fans, they are subject to rapid changes in character, with channels shifting laterally over a wide area and alternately cutting and filling themselves."[1]. The danger posed to the population by settlement on the alluvial fans used to be offset by the economic advantages to agriculture[2] (c.f. Chapter 5). Fertile sediment and spate irrigation were necessary for the success of the agricultural sector on which the economy of the Wadi

Hadhramaut was once based. Efficient throughflow of the valuable flood water to fields and gardens was achieved, within the channel network, by low weirs of stone and *ramaad* construction (*murSad*) and mud bunds[3]. Since the agricultural sector has decreased in importance through increased urbanisation and economic diversification, the systems of water dispersal have been neglected. For the townspeople, the proximity of the watercourse has turned from advantage to major disadvantage.

The effective working of the channel networks in Seiyun and Tarim are dependent upon the ability of the channels to disperse the flood waters. "Channels are crucial to the functioning of the [alluvial fan] systems."[4]. To protect the towns that have developed upon the fan systems, it is extremely important to keep the watercourses and channels as wide and as numerous as possible to accommodate water of both inconsequential and extraordinary floods. Constricting channels decreases the capacity of the channels to carry water from the catchment area to the main watercourse of the Wadi Hadhramaut turning, in effect, a normal flood into an above-average flood. Water rises more swiftly and to a higher level, putting the houses on the banks at risk. Once a mud house collapses, a channel can become blocked, endangering other houses. Large areas of the town can be also affected by floods should a channel change course. By overtopping one channel, a flood can fill another beyond its capacity and break out into another residential area.

Despite the fact that the majority of the population is now not involved in agriculture, the network and the structures that guided and dispersed the water should not be neglected. The flood diversion networks have taken on another role, that of defending the town from floods. With the increase in population and housing, the flood dispersal networks must bear more responsibility for the protection of the town on the hazardous alluvial fan. Maintenance of those systems is therefore vital. If the systems are being encroached upon, then strengthening and maintaining the walls and diversion structures in the channels becomes even more essential for the effective resistance of the town to floods. Modifications to the channels might even be necessary so that they can conduct larger amounts of water to a suitably absorbent area, or to the main channel of the Wadi Hadhramaut.

The process of urbanisation has further increased the importance of the channel networks of Seiyun and Tarim in the protection of the community. Urbanisation subjects the area affected to more rapid and copious runoff in the event of rain,

increasing flood peaks and reducing flood lag times. The more rain-resistant surface there is, the faster the flood rises[5]. The size of the flood is also affected by the amount of absorbent materials on which the rain falls; floods are larger if they cannot be absorbed. Areas of soft agricultural land in the towns of the Wadi Hadhramaut are currently being turned into areas of rain resistant surfaces: housing, asphalted roads and compacted-earth alleys. The chances, therefore, of a flood overtopping the walls of the channel has become more likely due to the greater quantities of runoff.

Unfortunately, the principles of division and absorption incorporated in the networks are no longer being upheld. The pressure exerted on available land in the towns has forced the encroachment of housing towards the watercourses and channels. The water dispersal networks in Seiyun and Tarim are also threatened by the growing trends of building houses and boring wells in fields[6]. Once a field is no longer dependant on spate irrigation, either because a pump has been installed or because a house has been built upon the land, the entrance to the field from the channels is blocked. These developments limit the capacity of the dispersal system to dispose of the water in a useful and safe manner. If the fields are blocked off, the water simply goes elsewhere[7]. Although the guiding structures within the systems are increasingly vital to the protection of the communities, their importance has not been matched by consistent repair. The only structure that is regularly repaired is the Muuza[c] diversion weir of Shibam. The implications of these trends are that increased water must be carried by the restricted and simplified network.

Encroachment and Development

Although houses have been built on the edge of, and in, watercourses and channels since the days of the Kathiiri sultanate under British rule[8], land shortage within the towns has significantly increased the numbers of houses constructed directly on the edge of the watercourse. Such construction always involves an element of gambling. As flooding in the various tributary valleys of the Wadi Hadhramaut is sporadic, an area may remain unaffected by floods for a few generations. That the land can be used for the length of time in-between is often considered to be worth the gamble. The use of potentially flood affected land can also be attributed to the "high degree of forgetfulness and naiveté often exhibited by people."[9]. However, if a flood were to damage such developments in the past, the consequences would have been on a smaller scale than if a similar situation were to occur today.

Many of the houses built on the very edge of the watercourses and channels have been constructed upon raised foundations. This practice is a feature of Tarim and Seiyun and Shibam. That people commission and finance deeper foundations near a watercourse is an indication that the inhabitants of the towns consider the threat of floods spilling into residential areas to be serious. New houses have been built with cement blocks on the banks of Algeria Street, Seiyun. The use of cement blocks for houses on the edge of watercourses is a new departure, they are thought to be significantly stronger than mud houses in the face of a flood. On the very edge of the single watercourse in SaHiil Shibam, mud houses that were destroyed during the floods of 1996 have been rebuilt on the same sites. For extra protection in the event of another large flood, by May 1997 the first storey of most of the houses had been built with cement blocks. Town expansion in Tarim has also crept towards the flood dispersal system. Due to the expansion of residential accommodation and roads, much of this system has been built over[10].

Policy

Watercourses

It was, according to Saalim BaaHumaid[i], absolutely forbidden during Socialist rule to build in the watercourses. If people did, they were compelled to destroy their houses and move it back from the edge[11]. He later invalidated his statement when he said that an engineer was employed by the *Baladiyya* to supervise the foundations of houses that were being built in dangerous areas such as channels[12]. The fact that such a role existed is proof that watercourse encroachment was not unheard of under Socialist rule. He further nullified his statement when he recounted the following story:

> While he was working at the *Baladiyya*, a man came into the office, demanding the right to build a house on his own land. The land that he owned was in a depression and prone to flooding. The *Baladiyya* forbade him, so he went to the Head of the Socialist party and complained. The Head of the Socialist Party wrote a letter, on behalf of the Party, abdicating all responsibility for the man's actions. The man presented his letter to the *Baladiyya* and they allowed him to build his house, putting the letter on file. After two years, a flood destroyed the

[i] He worked in the *Baladiyya* in Seiyun until 1980.

house. The man received no compensation and no assistance. He later went to apologise to the *Baladiyya* for not listening to their advice[13].

This account seems too neat to be true, the apology in particular sounds unlikely. It could be that the story was rumour or propaganda, disseminated by the *Baladiyya* to underline the wisdom of the Party, or a cover-up for some illegal licensing that the *Baladiyya* committed[ii].

Today, there are no legal guidelines regulating the construction of buildings near watercourses and channels in Seiyun. According to members of the Office of Housing and Town Planning in Seiyun, the necessary distances between the house and the channel are dependant on the type of watercourse or channel[14]. Although 'A al-B. M. BaaRaJaa' had previously said that no-one built near the watercourses in Seiyun[15], he subsequently estimated that the distance between a large channel and the house was about 9 m, 3 to 5 m for a smaller one[16]. It is telling that the Head of the Planning department does not know how far the house should be built from the watercourse. Another member of the Office of Housing and Town Planning, Rashiid, explained that it is forbidden to build near watercourses but that there is no specific limit of how many metres one should leave between the watercourse and the potential site. Again, it depends on the watercourse[17]. Some people build near small unimportant channels that can be diverted[18].

Houses have been built right on the very edge of the watercourses in Seiyun[19]. Although they are not necessarily constricting the channel, they are limiting the flexibility of the watercourse to cope with scouring. The location of these houses can be dangerous in the event of flood water rising above the banks. Close to the Salaam Hotel, there is a slightly raised mud bank on which is built a mud house with high stone walls, a motorcycle workshop, a block of flats at almost the same level as the channel, and a mud building outside which men gather to drink tea. The site of these buildings is between two channels, one narrow and tree-invaded, the other very wide and shallow. Not one of these buildings are the suggested 9m from the watercourse. The case is interesting because all the buildings were constructed at different times and under different legal status, and demonstrate different levels of vulnerability. (See figure 11)

1. The site of the first house has been built upon since pre-Unification days. Constructed of *madar* behind high stone and cement walls, it is situated directly in the watercourse at the point of divergence of the large channel (plate 6).

[ii] Whatever the origins of the story, Saalim BaaHumaid believed that it was true.

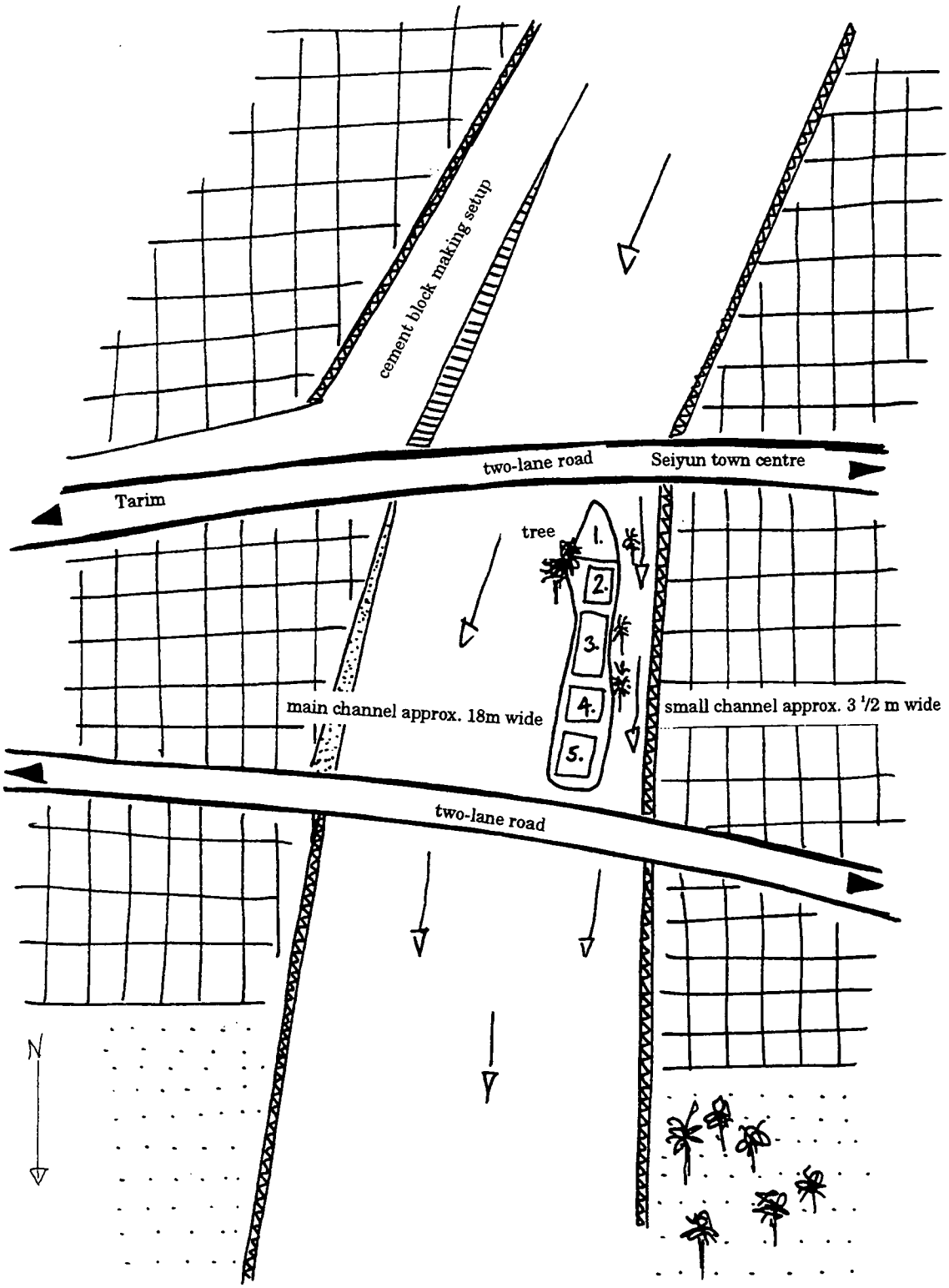

Fig. 11. Buildings constructed between two channels, Seiyun.

Plate 6. Building No. 1, Built between two water- courses, this house needs massive foundations

Plate 7. Block of flats (building 3) and the channel.

The vulnerability of the site is indicated by its extensive foundations and walls. The current house replaces one which collapsed in a previous flood when the small channel became blocked [20].

2. The next building on the sliver of land between the two channels is a motorcycle repair shop, built legally during the Socialist era[21]. This large mud-brick shed is on slightly higher part of the bank. According to the young owner of the workshop, during normal floods, the water only comes up to the base of the raised area where they repair the bikes.

3. The third building is a block of flats built with cement blocks (plate 7). Constructed two years ago, it is barely raised out of the watercourse. There is no step at the front door, and there is no bund between it and the watercourse. This building is supposed to belong to the deputy director of the Wadi Hadhramaut Agricultural Project who had it constructed by a trader friend[22]. The block of flats is currently unoccupied[23]. Of the buildings on the spit of land, this is the most vulnerable for no defence has been constructed to separate it from the flood course, as the first house has done.

4. The last building is also made of *madar* and is built on the southern side of the block of flats. It belongs to the brother of the head of the Electricity Corporation. Initially, building work had commenced without a licence. For a while, work on it was stalled until the owner was granted a license[24]. Although in the event of a major flood, the three buildings upstream of this building will collapse before this one and so are at greater risk, 'Abd al-Baary M. BaaRaJaa', Head of Planning in the Office of Housing and Town Planning, did not know why a license to build had finally been allowed[25].

5. Continuing down the same channel into al-Himma, a *kabs* (base of a house) was being constructed of stone and cement to a height of five to six feet. The apparent reason for the hefty foundations is the site of the house; it was being built at the junction of two roads which, during floods double as channels[26].

The crucial aspect of town planning around watercourses is to know the natural route of the flood. 'A al-B M. BaaRaJaa' said that any channel the Town Planning section has to define is made as wide as possible. Apparently, if they know the route the water takes, they can keep a space clear on each side[27]. Unfortunately, very few members of the Office of Housing and Town Planning have relevant expertise on channel management. Watercourse definition is notoriously difficult, in the event of abundant rainfall floods can carve new routes or revert to a old channel[28]. The course of Wadi Jetha' in the new suburb of Maryama, that was

designed by a group of planners from the Housing Office, is not the natural route of the floods[29]. The rubble bunds that demarcate the channel are therefore at risk. Apparently, if it were to rain for three hours continuously over Maryama, then the water would rise to a depth of 3 or 4 metres, enough to break the bunds lining the watercourse[30]. A member of that group admitted that he had never studied the subject of planning near watercourses during his time at college in ʿAden. His specialist course was surveying[31]

There are no studies on local watercourses in relation to town planning kept in the region[32]. Only one study on town planning in the Wadi Hadhramaut has ever been undertaken. In the months surrounding Unification, a Cuban team were studying town planning in the area, focussing on Seiyun,. The maps and reports that they produced were never seen in Seiyun, and never seen in the Housing Office where they would have been put to use. By chance, the Head of Planning in the Housing Office saw a few maps in a local government office in al-Mukalla. He believes the books are also in al-Mukalla[33]. In fact, these documents are held in the Office of Housing and Town Planning in Sanaʿa', even further from Seiyun. The reports are written in Spanish, a language no-one in the Office of Housing and Town Planning understands[34].

Although there is no specific regulation regarding the distance a house must be constructed from a watercourse, there is a policy which tries to ensure that individuals protect their own houses. If a man builds next to a channel or watercourse, then he must also construct a defence against the flood. This is usually a thick stone wall, bound together with cement which the house owner has to pay for with his own money. He also needs to obtain a licence[35]. If the defence will protect a small group of people or a single citizen, then it is their personal responsibility. Sometimes a group of people in one area will band together and pay for the defences. However, if many people are potentially threatened by a flood, then the government must take responsibility and build defences[36].

Agricultural Land

During the Socialist era, it was forbidden to build on agricultural land except for certain, limited areas[37]. This policy was linked to the protection of the agricultural sector and its labourers. Only if a man had absolutely no choice of land on which to build could he then obtain a permit from the Department of Agriculture and the local authorities [38]which allowed him to clear an area for a house. Since Unification, house construction has proliferated in palm groves, mainly to the north of Seiyun. One year after Unification, AHmed BaaKulka approached the Office of Housing and Town Planning in order to obtain a license to build a hotel[39]. To construct his hotel, he first had to clear a patch of palm trees. He needed no permit to do so. He mentioned that it was extremely easy to obtain the license for construction, the whole process taking about two days. Foundations for the hotel were started in 1992[40].

It is still possible to build in the palm groves but new restrictions have been imposed. These probably came into effect in 1994[41]. However, these restrictions are merely paperwork. In reality, if a person wants to build on his agricultural land then he may[42]. The Office of Housing and Town Planning can no longer forbid people building on their own lands[43]. The person requesting a license to construct must first present land ownership documents to the branch of the Department of Agriculture in Seiyun[44]. This procedure is often demanded by the Housing Office[45]. The Department of Agriculture give him a letter permitting him to remove the trees if he can effectively protest and prove that he has nowhere else to build. He takes that letter to the Office of Housing and Town Planning to demand a licence. In these situations, the Housing Office must submit to the authority of the Department of Agriculture. Sometimes, although rarely, a man will cut down all or some of his trees in preparation for building so that, when the Housing Office or Department of Agriculture visit the site, they are unable refuse on the grounds that it is valuable agricultural land[46].

The committee that was formed for the flood efforts of 1989 in Tarim, *lajnat mu'aalijat majaary wa-dhraar as-siyuul* (The Committee for the Repair of Watercourses and Flood Damage)[iii] was re-formed in 1996 after the town was once more subjected to flooding. The role of the committee has changed from disaster

[iii] The committee has sixteen members and permanent status (Hafiith Sabii', 27/5/97).

assessment and management of the relief process (1989), into an organisation that monitors the state of the channels and the urbanisation process. It also supervises the deepening of watercourses by citizens of the area, when they choose to do so with their own money[47]. The committee also influences the legal situation of the town. Even if it is privately-owned, building on agricultural lands is now expressly forbidden[48]. It is imperative that people who now build near the channels have to have plans for substantial foundations before the license to build is granted. This is a local regulation, introduced after the 1996 floods[49]. A similar committee was also established in Seiyun, but it does not convene[50]. Tarim has a better, albeit patchy, record for planning regulation than Seiyun. Apparently, following the flooding in Tarim in 1989, the Housing Office clamped down on building near the watercourses[51].

Since the sudden flourishing of the oil states in the 1970s and the high levels of money remitted by migrant workers[52], diesel pumps have proliferated in the Wadi Hadhramaut. The appeal of the diesel pump to a farmer who once relied on unreliable spate irrigation is indisputable. It offers a consistent supply that can be regulated as the crop needs. However, once a well and pump are installed then the floods become more of a threat than of benefit. Flood waters deposit silt and debris in the well, necessitating its rehabilitation. On the installation of pumps, channels that carried water to the fields were unnecessary and so are blocked up so that the floods would not damage the well and pump[53].

Disrepair of Structures within the Flood Dispersal Networks.

The role of the community in the prevention of flood damage to the towns through the maintenance of diversion structures changed with the ascendance of the Socialist party to power. In 1972, the Agrarian Reform Law of 1968[iv] was put into effect in the Wadi Hadhramaut. This law fixed the limits of agricultural holdings at 8 ha of irrigated and 16 ha of rainfed land per individual[54]. Land in excess of the determined amounts was requisitioned, redistributed among former tenants or formed into massive state farms and co-operatives. Much of the private land around Shibam, Seiyun and Tarim was requisitioned[55]: "In-spite of this provision in the Law, there is practically no private ownership in the project [WHAP] area and almost all land belongs to the State."[56]

[iv] Amended in 1970 (PDRY. A Review of Major Sectors and Development Assistance Needs. UNDP, 'Aden. Feb., 1975).

Incentives to invest in land and agricultural production were curtailed as the co-operative system removed any inclination to improve crop quality and quantity[57]. This resulted in a rapid decline community involvement in the maintenance and repair of the weirs and irrigation networks. Farmers participating in the co-operative schemes had to sell the produce to the co-operative society from where it would be sold at a fixed rate. Poor agricultural production was exacerbated by centrally-planned Socialist policies on crop production, for example, cropping patterns did not take into account regional variations in climate or fertility[58]. Poor labourers who had received parcels of land from the government could not afford to repair the structures. If land was privately owned, it was farmed by tenants. Land owners did not fully benefit from the land and so were disinclined to invest in the structures that protected it[59]. As the whole community was affected by the requisition, there was no social pressure to conform and contribute. Most importantly, the government was now seen to be solely responsible for the upkeep of the defences and irrigation networks as they were in charge, and seen to be benefiting from, the state farms and co-operatives[60]. Whereas in the past, the maintenance and repair work had been organised and executed by the community of landowners and their tenants[61], it now became the responsibility of the new owner, the State. People started to rely on government intervention for routine maintenance and post-flood reconstruction[62].

Unfortunately, the government did not perform the necessary regular maintenance. Repair work was executed only if necessary, a sorry change from the continual maintenance of many centuries. The lack of maintenance led to a decline in the condition of all the structures. In the immediate aftermath of a flood, only very minor repairs were undertaken by the community[63]. The majority of the repair work was accomplished by the government at the request of the communities. In Shibam, the surveillance of the state of the Muuza' became the responsibility of a committee. The equipment and funds required had now to be requested from the government, usually granted after a further assessment by a government team. Even later, the equipment such as bulldozers and cement was sent[64].

The disruption caused by the Agrarian Reform Law has not been confined to the Socialist period. Since Unification in 1990, and the attempted return of many lands to their original owners, uncertainties over land ownership has perpetuated the lack of long-term development and routine maintenance. In the centre of Tarim

and Seiyun, requisitioned land that was formerly agricultural, was sold off for construction purposes by the Socialists. This land has not been returned to the original owners, and no-one has taken on the role of repairing the weirs and bunds within town. The lack of maintenance on these features of flood prevention and mitigation is still being felt today. The gradual degeneration of the lands, weirs and channels over the Socialist period demand more investment than many of the local inhabitants can, or desire to, afford[65].

Only in Tarim does the community still play any part in the protection of their houses[66]. Sporadic clearance and maintenance of the channels on the outskirts of the town is performed by the agricultural labourers who own fields nearby. They are thus able to benefit from the increased flow[67]. In residential areas, residents sometimes deepen the channel near their homes at their own expense, and under the supervision of the Committee for the Repair of Watercourses and Flood Damage[68]. The Committee is also responsible for the upkeep of the bunds near the houses and on the entrance to the town of Tarim[69].

In Seiyun, the responsibility for the repair and upkeep of the structures has been lost between the three parties who are supposedly responsible: the Office for Housing and Town Planning, the Department of Agriculture and the *Mudiriyya*[70]. Each party hold the others responsible. Furthermore, in holding the government responsible, the community also takes no action. The result of the confusion is that no repair work is undertaken[71]. The overall responsibility lies with the *Mudiriyya*, as does the repair of the main channels[72]. If a major channel needs major work then an expert is brought in, there is no-one in the *Mudiriyya* in Seiyun who has the skill to do the work[73].

Many of the weirs (*murSad*) and guiding bunds in the main channels and their tributaries have now been demolished by cars[74], or are in a general state of disrepair (see plate 8). For example, one channel in Seiyun used to be split by a weir and a bund into three streams of water, neither of them are now in working order. As a result, water takes the lowest and easiest route. This route is neither the widest or the deepest. This situation is common throughout Seiyun, increasing the likelihood of a large flood rising above the stone walls of the channel and undermining the houses built on the side. Even if a flood does not immediately destroy a house, much damage can occur to a house built within a walled yard near

Plate 8. MurSad and channel in bad condition.

the water channel. Water that has overtopped the wall is gradually absorbed into the foundations of the mud house[75].

If money cannot be even spared for the upkeep of the system, then the strengthening or modification of that system is highly unlikely. In a conversation with the Deputy of the *Mudiriyya*, I asked him why the flood diversion structures around town were in a state of disrepair. Startled, he replied, "Are they? Perhaps they are in need of money...". He quickly turned on the Party platitudes saying it will be solved, obviously a major risk for mud houses. Since he has been in office (July 1994), rarely has he seen money go to repair these structures. Apparently the money usually goes to poor families affected by the Gulf War, or to repair roads and schools[76].

As Shibam is a World Heritage Site and therefore a good focus for aid, the repair of the Muuzaᶜ and its related channels are frequently funded by donations from abroad. The implementing agency is usually the Wadi Hadhramaut Agricultural Project. In 1982, within three days of the Muuzaᶜ being damaged by flooding, the WHAP bulldozer was commissioned to repair the broken mud fuse[77]. The highest point of the Muuzaᶜ, the *rakaba*, acquired a new section in 1992, but much of the original structure remains[78]. Immediately downstream of the weir is a series of gabions buried 1 ½ m underground for a distance of 6 m from the weir. These were installed 1992 by WHAP in an attempt to prevent scouring by floodwaters overtopping the weir[79]. AHmed Jerboaᶜ has been commissioned to work on the main irrigation channel of the network on a repair project funded from abroad[80]. In January 1997, the Sik was in the process of being repaired.

Public Opinion

Public awareness of the associated risks of channel encroachment is widespread. A mud-brick house cannot succumb to the hazard of flash flooding if it is built in an area that remains unaffected by floods. Without the protection that town planning on the raised land offers, these houses are in danger. Not only are these new areas are often more dangerous for the individual house and residents, construction upon them eventually increases the vulnerability of the whole town. The systems of water dispersal used in Tarim and Seiyun, and the diversion weir of Shibam are vital to the safety of the communities who built them. If these communities are

showing doubts about the systems which have been their protection for many years, then there should be cause for concern on the part of the authorities.

The concerns of the community are reflected by the guarded behaviour of the town planning authorities in Seiyun. During my first visit to the Office of Housing and Town Planning, none of the men to whom I spoke would give me their name. Even before any of the employees would speak to me, I had to go to the Director General of the *Mudiriyya* with an official letter from the British Council to demand yet another letter for the Housing Office. Initially, questions regarding the establishment of the new suburb of Jethma in an former area of water dispersal were not answered. Apparently, it was a "dangerous" question[81]. Frequently I would be told by men in the Office that there was no house construction in the watercourses. This contrasts greatly with discussions I had during visits to the Office of Housing and Town Planning and the offices of The Committee for the Repair of Watercourses and Flood Damage in Tarim. In Tarim, conversation about the issue of watercourse encroachment was completely uncensored. Not only did the people I spoke to admit that house construction near watercourses still occurred in Tarim and Seiyun, they also told me where in Tarim to find examples[82].

While waiting in the office of the director of the Office of Housing and Town Planning to speak with the deputy director, I was party to an argument between two men. This argument demonstrates the lack of a defined policy on planning near flood channels in Seiyun, and the high levels of awareness in the community to the importance of maintaining the width of the channels.

> One of the men had a license for his house plans from the Office, the other was his neighbour. The man with the license was in the process of building a cement house in the old town of Seiyun, near the women's market. His plot of land is also near a water channel about 2 metres wide. This is considered to be quite a small channel. Since a slice of his land was taken by the government for part of a road, he is edging closer to the channel. This was permitted by the Office of Housing and Town Planning. At the time of the argument, the trenches for the foundations had been dug. These, of course, are wider than the house eventually will be. However, in digging wide trenches, he has worried his neighbours. They are complaining, vociferously, that he will narrow the channel and that flood waters will threaten their houses[83].

An employee of the Housing Office suggested one reason for the complaints of the community about the issue of channel encroachment; apparently people who did

not receive free plots of land from the government are bitter, and therefore find fault with the efforts of the government to solve the housing situation[84]. The episode above shows that such a proposition is fatuous. Free plots were not involved in this issue, people complain when their interests are under threat.

Case Studies

Seiyun has yet to experience a major flood since the process of rapid urbanisation began and so has not yet suffered as a direct cause of house construction in watercourses. However, the concern amongst inhabitants of the towns is that, having once experienced damage through as a result of flash flooding, they are now susceptible to disaster. No-one is sure of the implications on the town of the recent building spree, especially since flood defence construction and the strengthening of the dispersal network have not kept pace with rapid development. On the examination of the reasons which increased the vulnerability of Tarim to floods in 1989 and 1997, and Shibam to the floods of 1989 and 1996, one can pick out similar trends that are occurring in Seiyun today. These case studies show the unstable planning base on which the rapid urbanisation since Unification has taken place, the effects of this incompetent planning, and the disastrous potential for the towns in the future. Through the gradual development of previously spate-irrigated land and the encroachment of houses towards the watercourses, Seiyun runs the risk of becoming as vulnerable to flooding as Tarim and Shibam, potentially more so because of its larger population.

Tarim, 1989

House construction in the quarter of MuHaidhara in Tarim began in the days of the Kathiiri sultans[85]. Houses had been constructed on the very edges[v] of a small channel that had been remained unaffected by floods for many years[86]. The channel was therefore constricted[87]. The licenses for this group of houses were issued before the 1970s[88].

In March 1989, it rained heavily from evening to dawn in Tarim[89]. During the night[90], floods originating in Wadis ʿAidiid and Thibi[91] flowed down the channels

[v] Some people say that the houses were built directly in the channel.

into the town. The flood from Wadi ʿAidiid was greater than that of Thibi[92]. A sketch, illustrating the path of the flood is given in figure 12.

From the head of Wadi ʿAidiid, the rain poured off the *shuHura*, into the main channel that flows through the former garden suburb of Tarim, irrigating the small-holdings before reaching town. The water was given the opportunity to disperse slightly before running down another channel at right-angles to the dispersal area. This channel leads to another dispersal area full of palms just 100′ below the famous MiHdar mosque[93]. It was in this old channel that houses had been built.

The first house in the channel was undermined by the flood waters and, being a mud house, disintegrated into the watercourse and blocked it. Three other houses then collapsed[94]. Altogether, four mud houses were completely destroyed as a result of this flood, six or seven houses were badly damaged[95]. One child from the BaaSHaaga family died and two lorries were lost[96].

The waters flowed on, through the palm grove by the MiHdar mosque, over a weir and on to converge with another stream of water which had run past the al-ʿIsha palace. The combined flood then headed through the channel to an area called BaaHowaash[97].

Holes measuring about 2 m by 1 m in the mud wall across the channel were designed to let flood waters through. Unsurprisingly, they were rapidly blocked with rubbish and detritus carried by the flood from the palm groves. Again the flood backwashed, severely damaging the houses it surrounded. The house of ʿIisa al-Kaaf (who recounted the story to me) was touched by the floods but not harmed. Eventually the wall in which the holes were built gave way, and the waters rushed through and down to the main channel of the Wadi Hadhramaut [98].

This account shows the knock-on effects of poor planning. Not only did the construction of houses in the channel constrict the available space for the effective throughflow of the flood waters, the collapse of one house in the channel affected nine others. Even though the houses should not have been built in the watercourse, the distance between the buildings should at least have been able to accommodate the potential collapse of at least one house without blocking the route for the flood and causing damage to others[99]. Poor planning also caused damage to

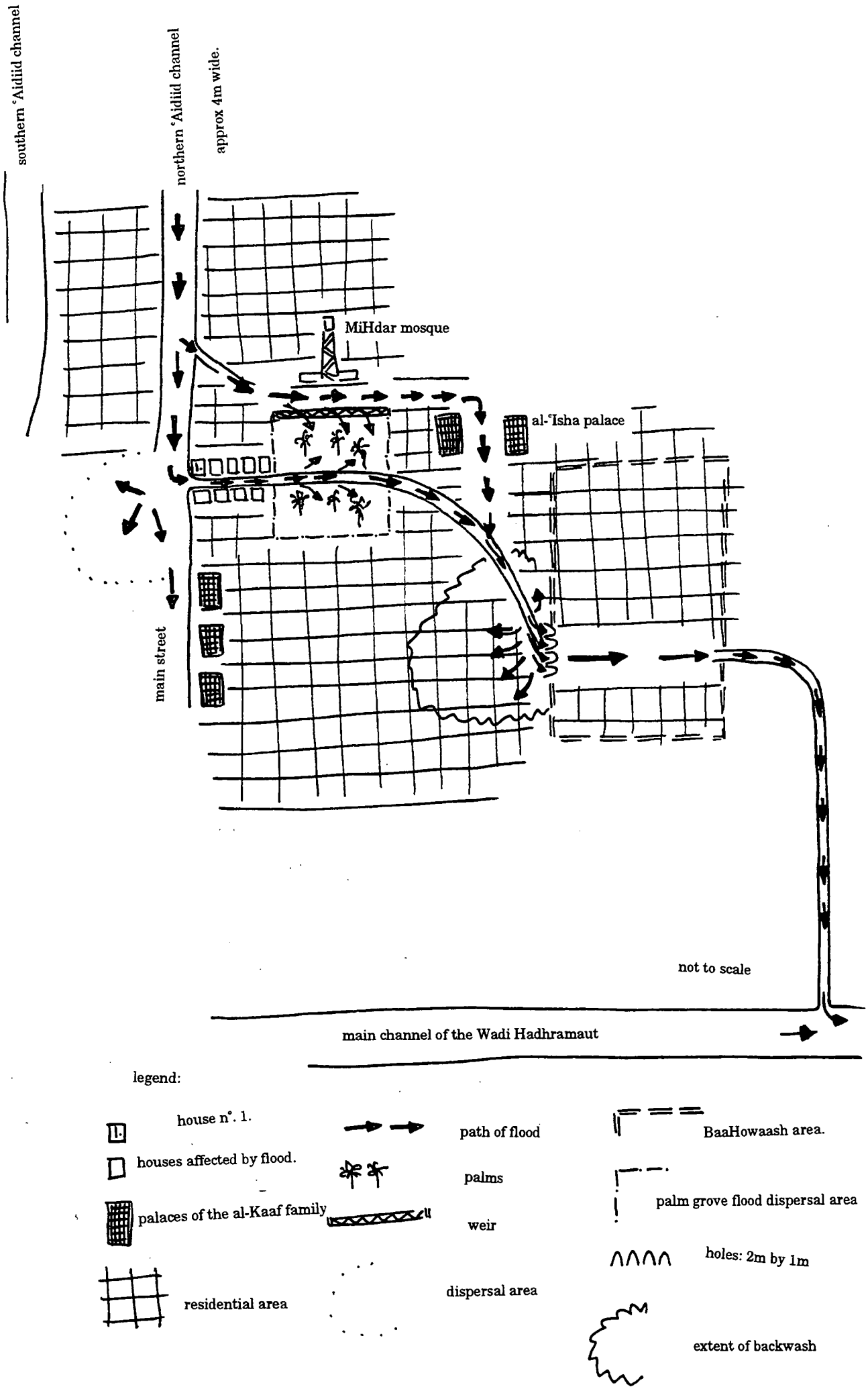

Fig. 12. Tarim 1989, showing flood route.

the houses in the area BaaHowaash. The holes left in the mud wall were incapable of allowing the flood water and its burden of palm debris through. It should have been obvious that flood waters channelled through palm groves before reaching the wall would be carrying large loads of agricultural debris.

Shibam, 1989 and 1996

Shibam has suffered through the gradual encroachment of houses towards the main watercourse that divides the town and the suburb, SaHiil. Originally, settlement of SaHiil was directly under the cliffs[100], but the combination of the area's limitations for expansion and growing numbers of people has, once again, increased the likelihood of disaster. The three or four rows of houses directly above the watercourse in SaHiil[101] are significantly more vulnerable than the houses in the old town. These houses are raised above the watercourse, although not to the same extent as houses in the old town of Shibam[102]. The danger for these houses is the event of a flood which breaches the Muuzaᶜ weir.

This indeed was the scenario in both 1989 and 1996[103]. In the event of an above-average flood, the mud bund which links the stone Muuzaᶜ to the northern bank of the watercourse is designed to breach. This permits the waters that would have been diverted to the fields to join with the undiverted flow so that the irrigation channels and fields remain intact. The houses that are situated on the bank of the watercourse in SaHiil have only been built above the level of a normal flood, or a single flow of a large flood.

In 1996, the bund breached when a large flood backwashed when it encountered a blockage caused by a poorly-designed bridge under which the main irrigation channel should have flowed. The main watercourse was therefore filled to capacity. Flood waters rose up to the town wall of Shibam to the depth of slightly less than a metre[104], causing no damage to the houses within the walls. However, about 50m of the watercourse side of SaHiil was flooded[105]. Houses on the bank were eroded, became waterlogged and collapsed in flood waters that ran at peak flow for two hours before subsiding[106]. Twenty houses were damaged, and six were completely destroyed[107] (see plate 9). Apparently, the floods of March 1989 had been even larger than those of 1996. As in 1996, houses collapsed in SaHiil[108].

Plate 9. Destruction in SaHiil Shibam caused by the June 1996 floods.

Constriction of the watercourse has occurred as a result of the crush on available building land and a unhealthy dependence on the capacity of the Muuzaʿ and the irrigation network to divert large amounts of flood water to the north of Shibam. The serious backwash caused by the bridge over the irrigation channel shows the potential for the failure of the Muuzaʿ. Built following the floods of 1982, the bridge was supported by closely-arranged concrete supports which trapped debris and blocked the holes during the flood. An indication of the potential of the bridge to cause problems was given in 1984, when a relatively small flood damaged irrigation channels when the bridge blocked flood flow[109].

Tarim 1997

Before the 1970s, the ʿAidiid watercourse had been deepened to allow greater quantities of flood water to be carried in safety, and two weirs were built. A dividing weir was built on the ʿAidiid channel. At about the same time, a weir was also built in Wadi Gataba[110]. Before requisition, maintenance of the weirs had been the responsibility of the farmers who owned spate-irrigated farmland on the banks of the channel[111].

Hassan al-ʿAamaery lives in the quarter of ʿAidiid, in a house that is 50 to 60 years old. When he was small (he is now between 45- 50 years old), he could see the main ʿAidiid channel from the roof of his house, now he cannot. During the intervening period, new houses have sprung up on land that was formerly farmland, and now line the channel[112]. It was considered safe to construct houses in these areas because major floods in Wadi ʿAidiid are considered rare[113].

The danger that these houses are in was demonstrated by a small flood, caused by a mere fifteen minutes of rainfall over Tarim and the mountains[114]. In March, 1997, floods rose in Wadis ʿAidiid and Gataba and the two weirs were instantly destroyed as a direct result of twenty-five years without maintenance[115] (see figure 13[116]). Consequently, the unimpeded water rose over the banks of the channel and swilled around the rows of houses that had been built on the edge of the channel. The banks were badly scoured[117], but no houses were destroyed. In addition, a small branch channel changed route on its descent from the mountains, threatening houses in its new path[118].

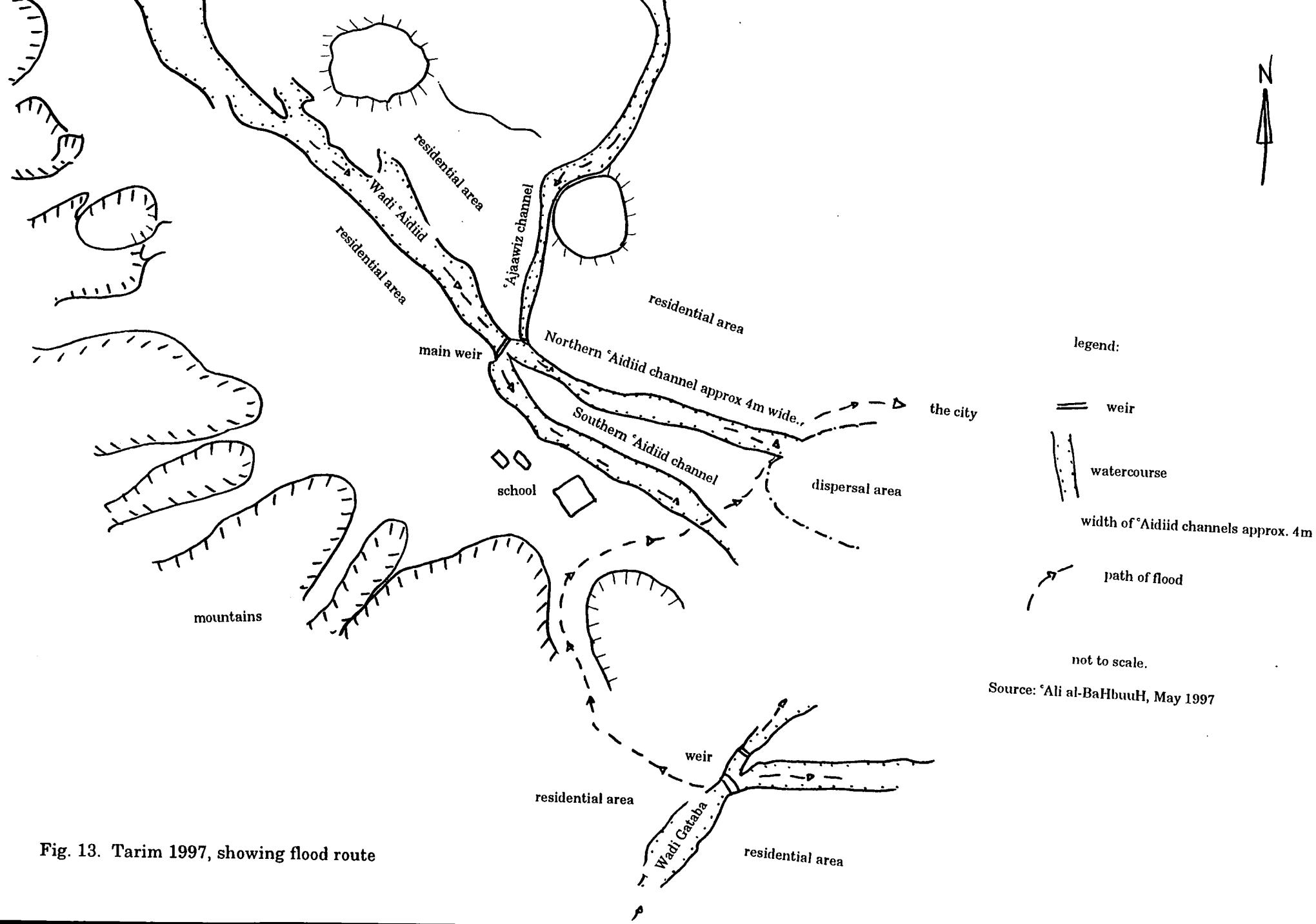

Fig. 13. Tarim 1997, showing flood route

This small flood event clearly shows the effects of construction on farmland, lack of maintenance to existing flood control structures and the dangers of building too close to the watercourse. The episode also proves the benefits of having substantial foundations under the houses. Fortunately, as a result of this event, building on agricultural lands near channels has now been forbidden by the committee in Tarim, even for people who want to build on their own land[119].

These events cannot be described as true disasters for the two towns as few houses were affected, there has been only one casualty, and the events did not affect the larger community or region. However, on a small scale, they show the potential for a major disaster should watercourse constriction continue, exacerbated by poor channel management, and augmented in scale by increased numbers of people.

Watercourse Encroachment in the Suburbs

Although the encroachment of the watercourses by houses, and the gradual construction on agricultural land are of concern to the residents of the three towns, the main concern in the communities, especially in Seiyun, is the establishment of new suburbs where the rapidity of expansion has outpaced the construction of hard flood defences. It is in these areas that residents anticipate disasters. Blame for the increased potential for disaster, not only in the individual developments, but for the likelihood of knock-on effects in the towns themselves, is being aimed at the government. It is the government who is responsible for the development of former wasteland near the watercourses, and who developed the suburb of Jethma primarily for the re-housing of evicted tenants.

Land earmarked for compensation or sale by the government are frequently wasteland areas and are sometimes vulnerable to floods. On Unification, the government had to relinquish the land that it had requisitioned from the owners in 1972, this left only the poor quality and dangerous lands that had either been common land or unclaimed[120]. The government has allocated lands upon these areas because the land belongs indisputably to the state[121]. Many of the plots of lands given to people for compensation as a result of the Presidential Decision of 1990, were located in areas close to watercourses[122]. The majority of those given plots were allocated land in the suburb of Jethma[123]. Of the plots of land offered for

compensation to evicted tenants in Tarim, most were located in ʿAidiid[124]. As Shibam SaHiil is almost full up with houses, a new area called Shigaaya has been laid out in the area to the east of Shibam. The corner markers of a row of plots have been laid out on the very edge of the main watercourse that runs through Shibam. Houses have yet to be built upon this land, although plots have been distributed[125].

Most of the houses lining the channels in Tarim were built after Unification on land belonging to the Kathiiri family, some individual citizens and the State. According to Hafiidh Sabiiʿ, a member of the Committee for the Repair of Watercourses and Flood Damage, the Office of Town Planning in Tarim is responsible for the narrowing of the ʿAidiid channel. People have been allowed to build in old watercourses and encroach on areas bordering the channel[126]. This process began in the 1980s and was exacerbated by rapid urbanisation after Unification. The state used to own the majority of the land which lined the channel and gave some of the plots as compensation for eviction, others plots were sold[127]. Those men responsible for selling space near channels in Tarim are still in office[128]. The issue is complicated by an apparent favouring of sites close to channels. Apparently, a good plot of land in Tarim is one near the watercourses as most of the year, the road/ channel makes the area easily accessible from the town[129]. To obtain a "good plot" a letter must be presented to the Housing Office[130]. The fact that there have been no major floods for a while seems to have reduced levels of common sense.

Prior to the construction of rubble bunds at the edges of the watercourse in Maryama, construction in areas close to the watercourse was unsurprisingly unpopular[131]. (See figure 14). Even now, plots that border the watercourses are cheaper than those farther away or on slightly higher ground[132]. The first houses to be built in Maryama were those on plots far from the watercourse[133]. People are still wary of building near the watercourse, and with reason. At present, the bunds that guide the waters of Wadi Jethaʿ in Maryama are of piled earth and stones[134]. Rubble bunds offer little resistance in the face of a large flood, particularly if the route arranged for the flood is not its natural course. In order to return to its original route, a flood can easily scour the unstable bunds. A plan has been submitted, proposing the construction of stone and cement walls along the length of the Jethaʿ watercourse, replacing the bunds[135]. This is apparently the responsibility of the State; the inhabitants and future inhabitants cannot afford such an undertaking. Despite the potential threat of the relatively unprotected houses

Fig. 14. The suburb of Maryama: recent planning, construction and the watercourse.

not to scale

Source: Sa'iid 'Awth MaHfouth, 25/5/97

caused by the inadequate defences, at the moment it is still permissible to construct one's house near the watercourse[136].

Jethma, a Case Study.

Before Unification in 1990, the town of Seiyun did not extend further south than the hospital at the end of Algeria Street. No development had occurred beyond the hospital, the southern regions of Wadi Jethma were nothing but barren wasteland segmented by two broad and undefined feeder channels. Jethma was nothing more than the name of the valley in which Seiyun lies. The word *jethma* means motionless, sitting or lying. Today, this definition has become unpleasantly apt; the inhabitants of Seiyun refer to the suburb as a "sitting duck"[vi].

The creation of the new suburb of Jethma is the cause of much concern for the residents of Seiyun. Invariably, it is to this new development that they point when referring to building in watercourses. Concern is expressed, not only for the inhabitants on the area itself in the event of a flood, but the consequences upon the whole town. In the mid-1950s, Seiyun experienced the worst flood in their living history, the *Sail as-Saba*ᶜ [vii]. Memories of the flood have been stimulated by the recent development of Jethma, inhabitants of Seiyun fear that a repetition of the events of the 1950s will destroy Jethma and damage large sections of the rest of the town[137].

Generally considered to have occurred in between 1954 and 1957 (aS-Sabbaan gives the precise date of 6 April, 1955[138]), the *Sail as-Saba*ᶜ flooded Seiyun on the seventh day of *Ramadhaan*. Although few people in Seiyun remember the year, the date has been immortalised in the name. Neither has anyone any problem recalling the time that the flood started to run down the Jethma watercourse into town, for the flood reached its peak just before break-fast, at about 5 o'clock[139]. At that time, Wadi Jethma was undeveloped and filled with palm and *jaᶜabuur*[viii] trees[140]. The watercourse filled with the uprooted trees[141], forcing the waters to run elsewhere. This caused widespread destruction in the lower reaches of the town. The flood even reached the Sultan's palace on the cliff skirts and damaged buildings in the

[vi] The suburb of Jethma has another name, *sheeshen* - Chechnya. When the first residents started to move into the area, electricity and water had still not been connected. The nickname was coined when comparisons were drawn with the television pictures of the war that was raging in Chechnya at the time (ᶜOmar al-ᶜAamery, 15/1/97, Abu Bakr Saalim al-Haamid, 14/5/97)

[vii] The Flood of Seven.

[viii] The branches and twigs of the *jaᶜabuur* tree were used in ceiling construction (Jaᶜafer as-Sagaaf, 6/3/97).

market place[142], some distance from the watercourse. Many houses were destroyed, most of them by the watercourse[143]. The southern tip of the alluvial fan were completely inundated, including the area in which the new suburb of Jethma is now built[144].

Settlement

Development began in the suburb of Jethma when the Presidential Decision to compensate former tenants of the Socialist regime was put into effect. The majority of the 1,000 -1,200 plots allotted for compensation were laid out in the triangle of wasteland between the two broad watercourses beneath the Muz'aan [145].

> From 1969 until 1994, SaaleH 'Abd al-BaHri resided with his parents in a government-let house in the middle of Seiyun. They had moved to Seiyun from the village of Ghuraf and, as his father was in the army, they were immediately allotted a requisitioned house with rent of only YD 1 per month. Following the Presidential Decision of 1990, he and his family were given two plots of land in the newly-plotted area of Jethma. They were permitted four years to build the new house and move out of the rented one. Since his father had amassed sufficient capital, the family kept both pieces of land and built a large house with a yard around it[146].

As part of the plan devised by the government allowed the sale of one of the plots, land became available for the rest of the community. Almost immediately, the opportunity to buy land was seized by many people from both the community and rural areas. Plots in the suburb of Jethma were considered especially desirable as the suburb is conveniently connected to the town centre by the main road, Algeria Street.

For the wealthy members of the community, it is usually voluntary to live in a risky area, for the poor it is not[147]. This is shown by the patterns of urbanisation within the town of Seiyun, both wealthy and poor inhabitants have made their homes in Jethma. Unfortunately, many of those who are currently building their houses in Jethma are those who have little choice of site. In Seiyun, about 10% of the plots planned in the last seven years have been given to former tenants of the state. Many of these were originally Socialist Party workers and supporters (for example, BaHri's father, see above), rural to urban migrants and of the lower classes[148]. That many of them required land for selling and for building upon gives an indication of their level of poverty, having no land holdings and insufficient capital to raise a

house. Government land is considerably cheaper than private land, it therefore follows that poorer families buy from the government[149]. This is a double handicap for government land is often in vulnerable areas. As land in Jethma has been sold by the beneficiaries of the government, the opportunity to build has been taken by the residents of Seiyun who had sufficient accumulate capital to afford construction. Many of those currently building for investment have worked, or are working in the Gulf and Saudi Arabia.

Flood Defence Plans and Confusion

When the plans for the creation of a suburb in the middle of the wadi bed were first proposed, plans were developed for the comprehensive protection of the area from flash flooding. In 1990, engineers from the Wadi Hadhramaut Agricultural Project were commissioned by the Office of Housing and Town Planning to design and create the flood defences[150]. This plan was to be submitted to the World Bank for funding. SaaleH ʿAwth Shaghdaara and Anwar Sagaaf were given responsibility for the drawing up of the project plans. Two channels were designed, one on either side of the triangle of land below the Muzʿaan, as southward extensions of the two main channels, Algeria Street and Guesthouse Road. A layer of rubble two meters thick was to be laid within the triangle delimited by the two channels. The channels were to be the same width as the two main streets so that water did not build up at the point where the extensions joined the original road. Having a uniform width was designed to increase the throughflow capacity of the channels[151]. The channels were to be defined by stone and cement walls[152]. Drop weirs were to be built in the watercourse to reduce the velocity of the flood waters[153]. It was suggested that another dividing structure such as the Muzʿaan could be built[154]. Plans for the excavation of a large hole above the Muzʿaan were also proposed[155]. This holding basin would retain flood waters providing an opportunity for evaporation, and infiltration through the gravely wadi bottom[156]. Shaghdaara admitted that this proposition had its limitations. As flood frequently happen in series, a preliminary flood could fill the basin; the second would flow unrestrained over the top[157].

Shortly after the allocation of plots in 1990, house construction began on the site[158]. In 1992, the Office for Housing and Town Planning pre-empted the submission of the design documents and began to create large rubble bunds along the proposed channel edge[159]. Currently, flood defences for Jethma start at the Muzʿaan which

separates a diverse flood channel into two broad channels[160], the origins of Algeria Street and Guesthouse Road. These channels are defined by rubble bunds of about seven foot in height. Of the other elements of the plan, only the scheme for laying about two metres of mud and rubble on the triangular site has been adopted[161]. Temporary measures have been implemented, the grand plan has been laid aside[162], although the expectation of its implementation has not been relinquished.

The majority of the members of the community to whom I talked, including engineers from WHAP, believe that the current protection offered to Jethma by the rubble bunds is inadequate[163]. Mud and rubble bunds are notoriously susceptible to breaches during flash floods. "Earthworks, even when grass-lined, are not highly resistant to strong velocities of flow."[164]. Localised erosion swiftly leads to a breach in the bund. Overtopping of flood defences can also lead to their destruction since the water erodes both sides simultaneously as it cascades over the structure[165]. As the channels were defined before the study on defence design was completed, it is suspected that they are not the floods' natural channels[166]. According to Saghdaara, there are bends in the channels themselves. In the event of a large flood, the bunds on the far sides of each channel will be especially vulnerable[167]. Similarly, the flood waters can wash out a bund when they are forced to slow down the ground levels out and the channels narrow. This occurred in 1989, at the entrance to Guesthouse Road [168]. If the bunds break, the bulk of the suburb will be inundated by the flood waters.

Even if the bunds were not destroyed by their overtopping, the flood water will still cause significant damage amongst the mud houses of the suburbs[169]. Most of the houses now constructed in Jethma do not have substantial stone foundations such as those near the watercourses in Tarim. The water will therefore be absorbed into the structure of the mud houses as the flood ponds in the lower land behind the bund. Some protection is offered by the heaping up of rubble and mud within the bunds[170]. This extra height supports the bund and makes the area slightly less vulnerable to flood destruction. However, the amount of protection offered depends upon the stability of the rubble. If the rubble is unstable, then the floods will simply wash out the bunds and the accumulated stones and mud[171]. The one area in the suburb that is deemed safe from floods, is a small triangular patch of land close to the hospital. Apparently, flood waters never rose as far as this raised piece of land[172].

As demonstrated during the *Sail as-Saba'*, Jethma was an area where floods dissipated[173], reducing velocity and providing the opportunity for water to permeate the gravel wadi bed before it flowed through the town. The existence of the suburb of Jethma is expected to raise water levels in the channels further down the system since floods are no longer able to disperse over gravely ground until they emerge on the northern side of the town[174]. Although the establishment of Jethma has neither increased or reduced the velocity of the potential flood waters[175], there are concerns that speed with which the waters flow will seriously damage the now restricted channel network[176]. The implications of the development of Jethma on the rest of Seiyun are, at the moment, imagined rather than known, for studies have yet to be done. Nevertheless, as the whole of Seiyun's town centre is downstream from Jethma, the consequences of a disaster in Jethma are likely to result in a catastrophe in the town itself, affecting the market and administrative areas as well as thousands of houses[177]. "This is a very big problem," said SaaleH Shaghdaara, "God has been kind.", so far[178].

Case study: Seiyun, 1982

The potential for severe damage downstream of Jethma is shown by the case study of Seiyun in 1982:

At the point where the channel on the eastern side of Jethma joins Guesthouse Road, floods level out and disperse slightly before they are forced to run down the narrower Guesthouse Road[179]. In 1989, water levels rose, overtopped and destroyed the mud bund that protected the residential area to the north, al-Gurn[180]. Between 10 and 40 houses were destroyed[181]. If the bund protecting al-Gurn had not broken, then it is likely that even more houses in the neighbouring area of Hayy ath-Thawra would have been damaged[182]. Flood waters also entered some of the large houses in the area near the Salaam Hotel[183] further down the channel.

The level area and the narrow entrance at the top of Guesthouse Road, remain unchanged. However, since 1982, the steeper eastern channel has been defined by rubble bunds. These bunds have reduced the potential for dispersal in the eastern regions at the top of Wadi Jethma, thereby increasing the amount and velocity of water flowing down the channel. There remains the chance that such an event could happen again, but to a greater extent[184].

Considering the potential for disaster in the suburb, inappropriate disaster mitigation can be seen as more disastrous than a complete lack of foresight. A false sense of security has been instilled into the community, putting the community in a situation of greater risk, particularly as residents of the area are taking no preventative action for themselves[185]. The proposed plans for larger defences have kept the community in waiting in the expectation that the government will provide.

Unfortunately, great confusion surrounds the issue of the submission of the proposal to the World Bank for funding. SaaleH Shaghdaara said that he had never submitted his proposal, yet Anwaar Sagaaf said that a proposal had been presented three weeks prior to our conversation[186]. ʿAli BaHbuuH summed up the situation by calling it a "difference of opinion" between the Office of Housing and Town Planning[187]. ʿAbd al-Baary of the Office of Housing and Town Planning believes that the proposal which according to him, he and Shaghdaara worked on together[188], has already been submitted to the World Bank. The World Bank office in Sanaʿa' had never seen the proposal document[189]. ʿAbd al-Baary believes that the World Bank refused the US$ 3 million[190] needed for the project on the grounds that a previous project for the comprehensive sewerage system of the town must first be completed[191]. He asked me to ask employees at the World Bank office and at the Ministry of Planning and Development in Sanaʿa', exactly why the proposal had been rejected[192].

For projects in the Wadi Hadhramaut, the World Bank works through the implementing agency, the government-run Wadi Hadhramaut Agricultural Project. It is to the Head of WHAP, AHmed Kriisaan, that any proposals for funding should be submitted. He, in turn, forwards the plans to the offices in Sanaʿa' and Washington[193]. Naji Abu-Hatim of the World Bank believed that the proposal for flood defence construction around the suburb of Jethma had been accepted, although he was unsure[194]. He was familiar with the general proposal although he had never seen ʿAbd al-Baary's plan, no plan had been submitted to the Sanaʿa' office. He thought it highly unlikely that a proposal for flood defences should be refused, particularly in the aftermath of the disastrous June 1996 floods. He also said that the lack of movement on the project had nothing to do with a lack of money. In fact, in 1995 US$ 4 million had recently been cancelled from the budget allocated to WHAP because the money was not being used. They still have not put the remainder to use[195]. The World Bank even planned to send an Egyptian engineer, financed from a budget other than that allocated to WHAP, to help the

engineers in Seiyun to formulate the plans for the project. WHAP have not taken the World Bank up on its offer[196].

According to some sources in Seiyun, the government is responsible for the creation of flood defences[197]. In the Ministry of Planning and Development in Sanaʿa', the Director General of the Agriculture Department, ʿAbd ar-RaHmaan M. Tarmoom corroborated Naji Abu-Hatim's statement that the problem was not financial[198]. "It's our people's fault." he said, "the problem is with us.". He attributed the situation to the lack of motivation of those in the government's employ, both in WHAP and in the ministries[199]. There was, he said, no reward for working. This point had been brought up by Abu-Hatim who mentioned that *Hadhaarim* had lost interest in working after Unification[200]. Christopher Ward, also of the World Bank, said that I was unlikely to find out the cause of the chaos from the Sanaʿa' end [201].

The Response of the Inhabitants of Jethma

The denial of access to knowledge, both general and hazard-specific, is the denial of power. With power, people are able to protect themselves against hazards by taking independent action such as buying land in safer areas or creating substantial foundations. Without knowledge, the inhabitants of the area are more vulnerable to the hazard. Although the defences constructed around Jethma are considered inadequate by the majority of the inhabitants of Seiyun, this knowledge is of a general nature rather than specific facts, an ineffective base for argument. As shown above, it is certainly not in the interest of the Housing Office or the WHAP to inform people of the dangers of the area. SaaleH ʿAbd al-BaHry, according to his friend, Hassan Baahashwaan, knows about the dangers of Jethma but continues to live there because he has no choice for both land and money are limited[202]. Those who do not know about the dangers of the area are ill-educated[203]. Laylwa, a widowed cleaner lives in Jethma with her six children in a *madar* house. She enjoys living in Jethma, even when it rains. She and her family have a picnic and watch the waters rush by. She describes the suburb as being surrounded by water, as the sea. Even when this happens she is unafraid, relying on the *nuura* on the roof and the cement on the floor for protection[204].

Coupled with the lack of information on the issues involved is a sense of impotence. Together they conspire to paralyse the affected people. The Office of Housing and Town Planning has yet to be approached by the community either in protest or

demands for protection. There is, apparently, no point, the Office is in "chaos"[205]. This has already been demonstrated by the fiasco of the submission of the World Bank proposal. No protests and demonstrations about the issue have been held. Demonstrations were forbidden during Socialist rule and *Hadhaarim* have not taken the initiative to reinstate their right.

Effects of Government Involvement upon Co-operation

In 1986, R. Lewcock wrote about Shibam:

> "It is probable that the traditional way of life is so closely allied to the environmental framework that the survival of both can be mutually supported as a complete "structural" pattern. There may even be a tendency for it to be self-generating, so that gaps in the environmental system will be reconstructed in an adjusted version of the traditional pattern."[206]

Unfortunately, the "traditional way of life", including patterns of co-operation that were founded in the agricultural framework, is on the decline. As the trend in the Wadi Hadhramaut is towards urbanisation and trade, the agricultural sector and its practices are becoming more distant. The way of life has proved itself inseparable from the environmental framework of agriculture. These changes started with the Socialist land nationalisation in the Agrarian Reform Law of 1968. As the land belonged to the State, the responsibility for the upkeep of the irrigation systems and bunds also lay in the hands of the State. In the adjustment of the "traditional pattern", the government has taken on the responsibilities that were once borne by the communities. This has been shown in the Jethma case study above. As the government allocated the land, it must also provide the defences. Co-operation now only exists amongst the smaller networks of friends and neighbours. However, even these structures have been threatened by urbanisation. Extensive migration to the Gulf states has exacerbated the loss of knowledge caused by the move from an agricultural society to an urban society. It is also possible that the movement of families to new suburbs has broken up patterns of assistance within the quarters.

Socialist policy has had a destructive effect on co-operation patterns and self-sufficiency in the three towns. The pervasive involvement of the Socialist government in daily life through its control of existing co-operation structures, has resulted in the inability of the inhabitants of the town to prepare themselves for a

flood and to repair the damage afterwards. Just as the repair of the Muuzaʿ diversion weir passed from the hands of the community to the control of the government by the formation of a committee under the regulation of the government, so too did the repair of the town wall of Shibam. Co-operation between the members of the community had been very important in old Shibam for the repair of the town wall; the families who lived in houses directly behind the town wall were responsible for its upkeep[207]. From the mid-1960s, this practice was gradually abandoned[208]. Lewcock reports that the inhabitants of old Shibam relinquished the responsibility for the wall's upkeep in the assumption and expectation that the government of this new modern state would take on the duty[209]. Indeed, as the government had requisitioned many of the houses in Shibam, the obligation to repair parts of the wall below lay with the Ministry of Housing rather than the new tenants. The result was that very little work was performed on the *suur* and, in 1977 and 1982, areas of the wall were damaged by floods, endangering and harming some houses within the wall[210]. By 1982, more than ¾ of the town wall needed reconstruction[211]. Similarly, in the towns of Tarim and Seiyun, the creation and repair of the stone defences that guide a flood became the responsibility of Co-operatives. Previously, the protection of their property lay with the owners[212].

It is interesting that the Socialist involvement should have so disrupted community involvement since the principle of community co-operation was part of the Socialist ethos. The trouble with codifying existing structures is that, once the government pull back (either by not providing wages or the necessary equipment to do the work) the community wait for the government to act rather than set up their own work projects, even if they benefit from the end results. The independent organisation of projects that necessitate the involvement of large sections of the community is difficult when the government has turned itself into the only authority in the area. This is particularly the case in the Wadi Hadhramaut. Before Independence, the *seiyyid* (*seiyyid* pl. *saada* "religious elite") and sheikh classes held positions of authority. On the rise of the Socialist Party, the upper classes like the sheikhs, the *saada* and the sultans were all discredited and the working class intellectuals assumed the leadership[213]. Galvanising the community into action, independent of the government, was therefore problematic. The working classes would not work under the discredited *saada* and sheikhs. They in turn would not work under the working classes. In this situation, there will always be some party who does not wish to contribute to the project. The confusion in

authority results in a lack of social pressure to conform. Unfortunately, with many of the defences against flash flooding, if there remains a place that is not repaired, the whole structure comes under threat in the event of a flood. This is particularly the case of the town wall of Shibam. The potential futility of the work was further disincentive. Problems associated with authority outside of government are still apparent in the Wadi Hadhramaut. On Unification with the north, the social structure was again turned upside down. The *saada* and sheikhs once more took up positions of authority but other classes were naturally reluctant to relinquish their hold on power. The result has been an increase in friction between the former rulers and the restored powers, the former authorities often seeking status and influence through religious fundamentalism[214].

The Effects of Urbanisation upon Co-operation.

Vital to the understanding of the reduction in co-operation is the fact that it is only a minority within the community who now benefit from flooding. As patterns of assistance were based, in the main, on the universal benefit of a prosperous agricultural sector to the community, the decline in importance of the agricultural sector has meant a corresponding decline in co-operation. Although there remain patches of agricultural land on the outskirts of the towns, the majority of the inhabitants of the three towns now work in trade or for the government, or rely on remittance money. These changes started with the requisition of land in 1972 and the rapid expansion of the oil state economies in the 1970s. No longer are there any *Hissi*-s in Shibam's watercourse. In response to the falling watertable, wells are deepened. The arrival of a flood now threatens modern bore holes and pumps since tubes fill with sediment and the water wrecks the machinery. Palm trees have lost much of their value in urban Wadi Hadhramaut. Today, top quality dates can be imported from Saudi Arabia and the Gulf quite cheaply, and fewer people rely on dates to the same extent as they did in the past when dates and heavy bread were the main components of the local diet. As the construction of many of the flood control structures was to maximise the gains of a flash flood, the co-operation of the community could be expected. Now, as the purpose of many of the old structures is to protect parts of the towns from flooding, the community as a whole is not concerned, particularly as few houses have so far been destroyed. With the construction of more houses close to the edge of the watercourses, and the establishment of the new suburb of Jethma, floods are becoming a pertinent issue in the discussions of the community. Nevertheless, action has yet to be taken.

A loss of common knowledge is to be expected when a hazard has not occurred for many years[215]. This, however, is not the case in the Wadi Hadhramaut where the hazard has been constant. As shown above common knowledge has been lost through government involvement in the prevention and mitigation practices of the community. However, knowledge of *Hadhrami* flood mitigation practices has no relevance to the large percentage of the male population in the oil states. Neither has it much interest, or seeming benefit, to traders and government employees in the towns themselves. Local knowledge has therefore been lost as a side-effect of the reduction of the active involvement of the community in disaster prevention. According to Sa'iid 'Abd al-Khayr, the generations of the 1960s know some aspects of flooding and the protection of Shibam, the generations of the 1970s and 80s know nothing[216]. A report by DHV Consultants on the 1996 floods in Shabwa governorate suggested that returnees from Saudi Arabia might have built some flood structures without sufficient experience, having interrupted the process of transmission by working abroad in different occupations[217]. The corresponding loss of skills and labour to an area hit by a hazard means that skills for maintenance and rehabilitation are not available[218].

The rapid urbanisation in the three towns has also affected the abilities of the communities to react in response to the occurrence of a flood. Although it possible that customs of assistance are still in place (despite the adverse affects of Socialist policy), because the expansion of the three towns has been so rapid, in practice this is unlikely[219]. Rural to urban migration, encouraged by discrepancies between town and village amenities, has disrupted existing quarter aid networks. More importantly, families who have moved from far off villages are left without the assistance of the extended family in the event of the destruction of their house by flood. The creation of new suburbs has caused the dispersal of inhabitants of the older quarters. This is the most vulnerable time for the residents of the towns: networks of assistance amongst people in the suburbs have yet to be formed, having only recently moved to the area and having experienced no flood together. In addition, so much money has been spent by so many families on the construction of new houses that, should a major flash flood hit any one of the towns (especially Seiyun), then many extended families will be left without capital for reconstruction. One positive conclusion may be drawn from the degeneration of the family pockets within the town by the development of suburbs. As families live in different areas, it is less likely that whole families would be directly affected by floods. Flood

stricken relations can therefore stay with members of the extended family in another, untouched area of town. The availability of remittance money to some of the residents of Jethma could be of benefit in the process of reconstruction. However, it remains to be seen whether this money will be shared within the neighbourhood.

Since Tarim and Seiyun are built on alluvial fans, controlling the flood waters is of paramount importance. Floods have a natural tendency to change the routes of the channels through which the waters pass. The maintenance of the structures which keep lateral migration of the channels to a minimum is very important, particularly as houses are being constructed on the very edges of the channels. The gradual degradation of the weirs and bunds in the town, combined with the gradual limitation of the system through construction on agricultural land, has increased the likelihood of the redefinition of the channels by a heavy flood. The consequences of such an occurrence could be disastrous. Although the potential for disaster has been increased by these developments, it has been augmented by the establishment of new suburbs in areas that have, historically, been inundated. The numbers of people in the three towns who are vulnerable to flash flooding have multiplied, notably since the flood protection works offered to them are so far insufficient. The disruption of co-operation patterns by the intervention of the Socialist government and the process of rapid urbanisation has reduced the capacity of the three communities to cope in the event of a disaster. As a result, a community will take longer to return to its pre-disaster state or a modified version of it.

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Conclusions.

The Republic of Yemen has been classed as one of the world's poorest countries, with a high rate of population growth at 3.4% p/a, large external debts and significant rural to urban migration. Since disaster, in any form, necessitates expensive relief and reconstruction, and causes the reallocation of external and internal aid and resources to the area of disaster, the fact that large areas of Yemen are subject to the hazard of flash flooding has serious implications on the future of the country's development. There is potential for a pattern of ebb and flow to emerge in the country's development as a result of the possible advent of three major floods seasons in a century, often occurring over the majority of the eastern regions.

Although the importance of major disaster has ramifications on the development of the whole country, in this thesis, I have examined the vulnerability of only three towns, Shibam, Seiyun and Tarim, to flash flooding. These three towns can be taken as a model for other towns in areas of recurrent floods for, like most of the towns in Yemen, they have been subject to rapid urbanisation. However, since the predominant construction material is the sun-dried mud brick, the effects of urbanisation and the subsequent encroachment to risky areas will be noticed much earlier than areas where houses are constructed with stone or cement. In their own right, these towns are important, for they have regional and country-wide significance; they are the three main towns in the 400 km long valley of the Wadi Hadhramaut. Seiyun is the administrative town for the inland area of the governorate of Hadhramaut, and Shibam and Tarim are famous for their architectural heritage.

Having defined disaster as affecting the whole town or region, with long-term social and economic consequences in the area, the towns under discussion have, since 1532, suffered damage rather than disaster as a result of flash floods. The majority of the flood events in the Wadi Hadhramaut have caused extensive destruction to the surrounding agricultural sector. Within the towns very little damage occurred, being manifested in the collapse of a few houses. Analysis of the three towns has revealed that the towns have been protected by town planning practices of building on raised ground, and mitigated by qualities in house construction and traditions of co-operation within the communities. The recurrent nature of flooding, combined

with stories, proverbs and songs, and local knowledge, have maintained awareness of the risks associated with flash floods.

Reflecting the increase in urbanisation, and the shrinking role of agriculture to the towns, in urban Wadi Hadhramaut the house is the most important possession in a family. Since the towns are primarily residential, measures of prevention incorporated into the construction of the house are important in the reduction of vulnerability to flash flooding. Protection of the house is offered by the construction of substantial foundations of stone and cement. The closer the house to the watercourse, the higher the foundations must be since, if the flood waters rise above the foundations, the mud bricks of the house absorb great quantities of water, soften and are easily scoured away. In the older sections of Seiyun, *dikuk* prevent flood waters from penetrating the foundations, and by raising the doorway above the level of the street, prevent the water from intruding and dissolving the thinner interior walls. The *nuura* plasters on the walls and roof of the houses are vital for the protection of the house in the heavy rains that precede the flooding.

Aspects of the construction of a mud-brick house serve also as mitigation. Should the house succumb to the erosive floods or the penetration of the walls by the water, the residents are given ample warning to evacuate since the house collapses slowly into itself. Great cracks in the outer walls appear as the interior walls fail. Even in construction, the mud house reduces the vulnerability of the population to the effects of flash flooding. A mud house is relatively cheap as all the materials are obtained from local sources. The fact that a house can be built in stages is important for it enables the home owners to build as they accumulate money, rather than when they have sufficient capital to build the whole house at once.

However, true safety for the house is offered only by the careful avoidance of the flood routes. Seiyun and Tarim have so far avoided major catastrophe by house construction on the high ground at the very edge of the wadis, and on the islands of sediment deposited by the floods. The control of the flood waters on the wadi bottom through channels, weirs and bunds has been important in the maintenance of the solidity of these islands. The origin of these methods of town planning lie in the need to protect the towns from both floods and tribal raiders, and to make the most of the valuable fertile land at wadi level for agriculture. Shibam has also avoided the dangerous lower ground by building on a small hillock towards the centre of the Wadi. Its suburb, SaHiil, is located on the high ground under the

cliffs of the *Jol*. The old town of Shibam is also protected by the mud town wall which surrounds the hillock. This too, served as a defence in the warfare between the rival sultanates of the Quʿaiti-s and the Kathiiri-s. Since Shibam is bisected by the main channel of the Wadi Hadhramaut, its safety necessitates more protection than Seiyun or Tarim. Following the floods of 1532, when half of the town of Shibam was destroyed, the series of weirs and irrigation channels that culminate in the Muuzaʿ were constructed. Since that time, the old town of Shibam has suffered very little destruction as a result of flooding.

Although the continuation of the principles of town planning and construction techniques are vital for the safety of the communities, equally essential to the protection of the communities is the active participation of the inhabitants in the preventative work before the flood and co-operation in the aftermath. Co-operation in the community existed at many different levels: between settlements, within the town, within the quarter and amongst the smaller communities of the neighbourhood and family. Vital for the agricultural sector was co-operation amongst farmers, landowners and labourers. The classes whose livelihoods depended upon success in the agricultural sector worked together on structures that also served to protect the town. These include the Muuzaʿ system in Shibam and the channel networks in Tarim and Seiyun. All networks served to mitigate the effects of the flood through flood warnings, and relief and rehabilitation in the aftermath.

Since the towns were founded on agriculture, the traditions associated with floods also relate to agriculture. These traditions govern the reaction of the community to the flood hazard for they nurture caution and vigilance, vital in preventative action. Such wisdom has been summarised in pithy proverbs, routines for post-flood work patterns are remembered with songs, epic songs recall the major flood events and the damage they caused, and observations on weather patterns are contained in almanacs.

Unfortunately, the town planning principles of building on the high ground and controlling the flood waters, and the traditions associated with agriculture and flooding, have not proved unassailable. Since the expulsion of the British in 1967, the erratic and extensive urbanisation of Seiyun, Shibam and Tarim has changed the relationship between the communities and flooding. No longer are the three towns inextricably linked to agriculture. The decline of the agricultural sector with

the rapid rate of urbanisation has disrupted many of the cultural practices linked to flooding, both in the oral tradition and in co-operation. Mitigation in the aftermath of the floods was once provided by the co-operative reaction of the community. Now, however, of these patterns and traditions of co-operation, only the individual's response to his families and friends remains.

In order to solve a country-wide housing crisis, the Socialist government passed a series of laws, culminating in the Housing Law of 1972. All houses in urban areas other than those occupied by the owner were requisitioned, including many houses in Shibam, Seiyun and Tarim. The government subsequently reallocated the houses to rural to urban migrants, friends of Socialist party and impoverished residents of the towns at token rents. In taking the houses that the former owners had built as investments and had let as businesses, and by undercutting the rent rates, the government froze construction for investment. Similarly, the anticipation that the government would requisition a house was a great disincentive for people to build any new house. By the late 1970s, the government had realised that their policies to solve the housing crisis had failed. They therefore resolved to invest heavily in the creation of houses, mainly in 'Aden, and to encourage the use of remittance money in the private sector. In the Wadi Hadhramaut, the changes in regulation resulted in a housing boom which remained relatively unabated, fuelled by continued remittance money from the Gulf and Saudi Arabia, until unification with the Yemen Arab Republic in 1990.

Expansion in the last seven years has outstripped even the expansion of the Socialist era. In 1990, a Presidential Decision was taken in which coalition government of the Socialist Party and the northern party, the General People's Congress, resolved to return requisitioned land and houses to the original owners. In compensation, the ex-tenants were given two plots of land; one to sell and with the money, build on the second. The result of the Decision was a sudden proliferation of cheap land, augmented by the continued sale of State land by the government. Many people seized the opportunity to build a new house while land was still cheap.

The limited land underneath the mountains and between the channels of the flood dispersal network has therefore been used to the full. Fewer and fewer options remain for expansion near the centre of the towns. Within the private land market, construction has taken place on the very edges of the channels that carry water in

times of floods, and in agricultural land and gardens that once absorbed the flood water. Construction in these areas could potentially result in damage to the houses built on the banks, it also threatens the individual towns with disaster should a major flood flow through the constricted and limited networks. It must be borne in mind that alluvial fans, such as those upon which Tarim and Seiyun are built, are risky areas for town development. Floods are likely to cut new channels into the previously accumulated colluvial material, and fill up older channels.

Since the flood channels of the three towns have the potential to change with successive floods, maintenance of the structures which keep lateral migration of the channels to a minimum is very important. However, as the majority of these structures such as the *murSad* and bunds in the channels of Tarim and Seiyun, were originally important for irrigation systems, the move from agricultural dependency to urban life has caused their neglect. The increased likelihood of the redefinition of the channels by a heavy flood will have disastrous consequences as new channels could only be carved through existing residential areas.

Where the private land market sold land in areas close to channels and in agricultural land, the response of the government has been to plot and sell off wasteland areas in neighbouring minor wadis. This includes the establishment of new suburbs in areas that have, historically, been inundated by floods. Of particular concern to the inhabitants of Seiyun is the suburb of Jethma. At present, in consequence of a planning fiasco, the suburb is protected from floods by large rubble bunds. These, it is acknowledged, are insufficient to withstand the assault of a major flash flood. It must be remembered that the majority of the houses are made of sun-dried mud-brick, and the majority of the town is residential. There is, therefore, great potential for disaster in the suburb itself, and catastrophic repercussions upon Seiyun downstream, unmitigated by the co-operation of the inexperienced and newly-dislocated community.

Having set out to ascertain whether the three towns of the Wadi Hadhramaut, Shibam, Seiyun and Tarim, are vulnerable to flash flooding, the conclusion that I have reached is two-fold. Until this point, the three towns have had relatively low levels of vulnerability due to the careful balance maintained between agricultural practices and urban life. Unfortunately, the recent trends have been the steady encroachment areas of housing upon agricultural land and into the channels of the water dispersal networks. The decline of the agricultural sector has resulted in a

corresponding decline in routine co-operation upon the channels and weirs, and has adversely affected patterns of community assistance both before and after a flood. The main cause of these potentially disastrous changes has been the careless mismanagement of the process of urbanisation by both the Socialist and present governments. The hazard of flash flooding is now posing a serious threat to the large numbers of people now living upon the alluvial fans and near the channels. Socialist policies have also affected community cohesion by their pervasive intervention in daily life through the codification of existing organisations, and the removal of incentives to invest in land. The current government is being held to blame by the communities for the creation of suburbs in areas known to be susceptible to flash flooding. Unfortunately for *Hadhaarim*, it is not the government that is based in Sanaʿa' that is at fault. The planning, sale and licensing of land in dangerous areas have all been managed by government employees who have been born and brought up in the three towns. Furthermore, the fiascos over the flood defences of the suburb of Jethma, and the lack of repair on the defences within the towns, have all originated in local government offices and agencies. Since, the government has, through the assimilation of the traditional co-operation patterns, taken on the role of protector of the three towns, these recent trends are a potentially tragic betrayal.

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ʿAbdullah Saalim Bin Hashlaan, driver for the hospital, *Shibaami*: 4/3/97, 8/3/97

ʿAli Saʿiid Shamaakh, agricultural engineer: 23/5/95 trip up Jethma, 24/5/97

ʿIisa al-Kaaf, *seiyyid*, Tarim, cousin to AHmed: 8/5/97

ʿOmar al-ʿAamery, teacher and researcher: 3/3/97, 15/1/97, 21/1/97, 25/2/97, 3/3/97

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Fawzi MuHammad, of Kenyan/ *Hadhrami* origin: 25/1/97

Hassan al-ʿAamery; works in the Museum, from Tarim: 20/5/97

Hassan ʿOmar BaaHashwaan, Arabic teacher and silver merchant:16/1/97, 19/1/97, 21/1/97, 24/1/97, 2/3/97 with Saalim ʿAbiid Bin Waliid, 18/1/97 trip to Jethma, 21/1/97, 22/1/97, 23/1/97, 25/1/97, 1/3/97 and friend from palace, 6/5/97, 8/5/97, 11/5/97, 18/5/97, 19/5/97 with his cousin, Jamaal BaaHashwaan, 27/5/97 with Anwaar Faaris.

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Hussein ʿAagil, Kenyan/ *Hadhrami*: 14/1/97, 19/1/97, 15/1/97, 17/1/97

Huud ʿAbdullah Bal-Khayr; trader:21/5/97, 24/5/97

Jaʿafer as-Saggaaf, local historian, *seiyyid*: 6/3/97

Lalywa Saalim Farry NaaSr, cleaner. Lives in Jethma: 2/3/97

MaHboob Sulayman, of Ugandan/ *Hadhrami* origin. His house fell down in 1996: 25/1/97, 27/2/97

Motorcycle repair shop owner: 22/5/97

MuHammad ʿAbdullah ʿAli Bin Hariiz, Shibam, 8/3/97

MuHammad Sa'iid 'Awth: works in Meteological Station at the airport: 21/5/97

SaaleH 'Abd al-BaHri, runs his own cinema in Seiyun. Lives in Jethma: 21/1/97, 2/5/97

SaaleH MaHfouth Saalim, accountant, spent his summer holidays building and used to work for the *Baladiyya*: 5/3/97, 5/5/97, 9/5/97, 13/5/97, 19/5/97, 26/5/97

Saalim Abu Karaama, *madar* maker: 1/3/97, 13/5/97

Saalim 'Abiid bin Waliid: 2/3/97

Saalim Farj al-Kathiiri, works in the hotel: 17/5/97

Saalim, a Kenyan/ *Hadhrami*: 15/1/97

Sa'iid Saalim al-Jaabery, Kenyan/ *Hadhrami* from Tarim: 18/5/97, 21/5/97, 24/5/97

SulTaana Sa'iid BaaSheikh, young bedouin woman, originally from Wadi 'Amd, now runs a stall in the market: 25/1/97, 11/5/97, 23/5/97 with her cousin and sister-in-law

Taalib ATTaaS, money changer, *seiyyid*: 8/5/97

Taxi Driver: 8/2/97

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'Abd ar-RaHmaan as-Sagaaf, Director of Seiyun Museum: 25/1/97, 10/5/97, 10/5/97

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'Omar AHmed Sa'aidaan, Finance and Administration Manager of the UNESCO office, Shibam: 4/3/97

Hafiith Sabii'; Head of the Committee for the Repair of the Watercourses and Flood Damage, Tarim: 27/5/97 with AHmed Abu Bakr

Hussein BaaMakhrama, director of the Agriculture Research Unit: 13/5/97

Manaaf 'Abd ar-RaHmaan 'Aboud, Head of the Department of Culture: 11/5/97, with 'Aidha BaaJary and Sa'iid 'Abd al-Khayr and Saalim MaHaywar

Mother of MoHsin ʿAlawi ʿAli , occupied a senior position in the Socialist party in the Hadhramaut: 3/97, written questions

Saaleh ʿAiderous Fudʿuq, head of the *Mudiriyya*: 12/5/97

Saʿiid ʿAbd al-Khayr, works in the Dept of Culture, songwriter and singer, originally from Shibam: 11/5/97, 14/5/97

Employees of the Offices of Housing and Town Planning

(did not want to give his name) MuHammad Birk al-Jaabery's (the director's) secretary: 12/5/97

ʿAbd al-Baary bin Mahdy BaaRajaa', Head of Planning: 12/5/97, 21/5/97, 24/5/97

FaiSal AHmed al-Sabiʿ, Head accountant: 18/5/97

Hafiith Mugabbil, worked in the *Baladiyya* in Tarim: 27/5/97

Khaalid, an engineer: 12/5/97

MuHammad ʿOmar BaaJabiir, former Head of the Housing Office: 6/3/97

Rashiid (did not want to give his full name): 12/5/97

Saalim Zain BaaHumaid, used to work in the *Baladiyya:* 19/5/97 with Manaaf ʿAboud

Saʿiid ʿAwth MaHfouth; town planning section: 24/5/97, 25/5/97, 26/5/97

Wadi Hadhramaut Agricultural Project employees

AHmed ʿAlawii Kriisaan: Head of WHAP, 15/1/97

Anwar Sahgaaf, engineer: 5/3/97

ʿAli ʿA. al-BaHbuuH, engineer for WHAP and member of the Committee for the Repair of Watercourse and Flood Damage in Tarim: 16/1/97, 18/1/97 trip to Shibam, 23/1/97 trip to Tarim, 25/1/97, 3/3/97, 13/5/97, 20/5/97

ʿOmar Ghaalib al-Kathiiri, engineer: 27/5/97

SaaleH ʿAwth Shaghdaara, irrigation engineeer: 26/5/97

Stephen Kissane, consultant for Coode Blizzard: 22/2/97, 26/2/97, 27/2/97, 28/2/97

Shabwa

AHmed MuHammad, from Wadi ʿIrma in Shabwa, shopping in Seiyun: 22/2/97

Shabwaani man from near ʿAtaq, staying in Seiyun, 17/5/97

AHmed bin MuHammad IHmad and his wife, from ar-Riaab, Wadi Dhura: 16/3/97

Atheer SalaaH ad-Diin Najm, Iraqi engineer with Oxfam's well rehabilitation programme in Shabwa: 19/2/97, 20/2/97: with Afrah al-Ahmadi and SaaleH Taahir, 20/2/97 trip to ar-Riaab, 11/3/97, 14/3/97, 15/3/97, 16/3/97, 18/3/97, 21/3/97, 24/3/97, 25/3/97, 26/3/97

ʿAadil, civil architect: 14/3/97

FaaTima AHmed, from near NiSSaab: 26/3/97

FaaTima, SaleH ʿAlawi's wife, from near NiSSaab: 18/3/97

Haraba BaaRaas, wife of Mubaarak. From as-Saʿiid, Yeshbum, Shabwa: 12/3/97, with her daughters ʿAida and Naadia: 19/3/97, 20/3/97, 21/3/97

Harm Dijkster, from TNO (Dutch NGO) based in ʿAtaq: 24/3/97

SaaleH Taahir's mother and the women folk: 23/3/97, 25/3/97

SaaleH Taahir, from near NiSSaab: 23/2/97, 24/3/97

Sheikha IHmed ʿAbdullah, from ar-Riaab:11/3/97

Wedding party in NiSSaab, various guests, all women: 18/3/97

Sheikh's wife in as-Saʿiid in Abyan: 17/3/97

Sanaʿa'

ʿAbd ar-RaHmaan MuHammad Tarmoom, Director General of the Agriculture Department in Ministry of Planning and Development: 4/6/97

Dr. ʿAbdullah al-Khamiisi, Secretary-General of the Yemeni Red Crescent: 7/1/97

Christopher Ward, of The World Bank: 3/6/97

Huib Wierda: 6/2/97

Khaalid Afiif, Head of the emergency flood unit in the Ministry of Planning and Development: 4/6/97

Faisal AHmed Mubaarak, employee in the Ministry of Planning and Development: 4/6/97

MuHammad Barakaat, CARE International: 7/1/97

Naji Abu Haatim, of The World Bank: 1/6/97

UK

ʿAbd al-Jabaar as-Sharafy: 21/11/97

Prof. T. Burt, Dept. of Geography, University of Durham, 31/10/97

Appendices

Appendix 1:

Floods 1225 - 1997

The first flood event cited occurred in **1225 AD** (623 AH) when flood waters from Wadis ʿAmd, Duʿaan, al-ʿAin and Haynin combined. Lots of trees were uprooted and many people drowned[1].

1249 AD (647 AH): damaged Shibam and 400 people in the valley drowned[2].

First major flood recorded at Shibam in **1298 AD** (698 AH): much of city destroyed by the flood[3]. SOGREAH estimated that the major floods of 1298 and 1523 had discharge rates of approximately 3,000 to 4,000 m^3/s[4]. Also destroyed a section of Shibam and some fields.

1323 AD (775 AH): uprooted palm trees throughout Duʿaan[5].

1356 AD (758 AH): damage to some property in Shibam, 14 killed.[6]

1391 AD (794 AH): floods in the northern wadis, Saar, al-Huun, and Thibi. Much property lost. The flood scoured out many palm trees in Thibi[7].

1446 AD (853 AH): A family, ʿAamer bin ʿAbdullah al-Taahiry, dammed Wadi Thibi. Just after its completion, a flood washed it all away[8].

1493 AD (898 AH): high floods in ʿAmd, Duʿaan, Saar, and Thibi, many people and much livestock lost, so too were palms and houses[9].

1495 AD (900 AH): a large flood, described in Shibam, as a flood of a size never seen before, although it seems to come only two years after the previous major flood[10].

According to Lewcock, the next major flood in **1532 AD** (939 AH) destroyed much of Shibam, although the damage was less than inflicted on the town in 1298[11]. SOGREAH estimated that the major floods of 1298 and 1532 has a discharge rate of

approximately 3,000 to 4,000 m^3/s[12]. The flood originated in Du'aan, uprooted 4,000 palm trees, eroded topsoil and spoiled fields. Apparently, the waters of the floods were higher than any seen before[13].

1562 AD (970 AH): rain fell continously on the coast and in the Wadi for days. All wadis flooded, and thousands of families were drowned in the lower regions of the Wadi and in Tarim. Waves of water uprooted palm trees and destroyed many houses. Shibam was also badly affected[14].

1582 AD (970 AH, same Islamic date given as 1562): 170 people drowned. Probably not centred around Shibam because only one person from Shibam was lost. Palms lost. This was a flood by which people dated other events[15]. Does not mention this flood in *namouthij tariikhi 'an ar-ray fi Waadi Hadhramaut*, ('Agiil).

1590 AD (998 AH): mainly in 'Idm but also in other parts of the valley. Destroyed palms[16].

1687 AD (1098 AH): destroyed stonework, a mosque and agricultural land around Shibam[17].

1717 (1124 AH): uprooted many palm trees, scoured lots of topsoil (particularly around Shibam), and drowned a large number of people. A large number of animals were also drowned. eg. camels, sheep, even wild animals. The flood also uncovered ruins[18].

In the middle of the same Islamic year as **1717 AD** (1124 AH), a mighty flood originated in Wadi 'Idm. Many palm trees were uprooted and the town of al-Ghuraf was eroded. Many palms were uprooted in the area, including many in Tarim. Some houses in Tarim were also destroyed, and up to ten mosques that had been built on the banks of the watercourse were damaged. Some migration of families occurred in the aftermath. A village in the region of 'Ainaat was damaged. Mosques and houses in 'Ainaat were also destroyed[19].

In the year **1914 or 1913 AD** (1323 AH), many floods occurred: Wadis 'Amd and Du'aan flooded, preceded by floods from Wadis Rakhia and 'Irma (these wasdis are at the western end of the Wadi Hadhramaut, 'Irma floods towards the Ramlat as-Sabatayn). Another flood emanated from Wadis Saar and al-'Ain[20]. This flood was

named after the Bin Ramidaan family who were all washed away as they celebrated a wedding in an area west of Shibam. Documents such as certificates of birth and landownership written after the event are dated using the name of the flood rather than the Islamic date [21].

1948/ 49 AD: this flood broke the famine that occurred in the Wadi at the end of the Second World War[22]. It affected Shibam.

1954 AD: "Exceptionally bad weather in many parts of the world during the spring, summer and autumn of 1954 gave rise to great floods which caused heavy losses of life, large scale destruction of property and widespread damage to crops and agricultural land." Central Europe and Western Europe, India, Pakistan, Nepal, Tibet, China, Persia, Mexico, Japan, West Indies, USA all affected[23].

In the early hours of the 18th July, 1954, Wadi Du'aan was swept by a floods from Wadis Hamouda and Minewa. The estimated depth of the flood at its peak is 50'. The flood lasted for four hours and had a front wave half a mile wide[24]. The main damage occurred to a 10 mile stretch of the wadi, the flood uprooting valuable *'elb* trees and date palms, eroding agricultural land and depositing gravel and rocks on the remainder. Much of the irrigation network was destroyed[25]. Eva Hoeck in Doctor amongst the Beduins [26] mentions that the flood waters flowed as far as Shibam, Seiyun and Tarim. Hans Helfritz also describes a flood in Tarim, but fails to give a date although his journey took place in the early 1950s. He reports that seventeen houses were destroyed, much of the town walls had been washed away and wells were blocked with sediment[27].

Generally considered to have occurred in the mid-1950s ('Abd al-Gaadr aS-Sabbaan gives the date 6 April, **1955**), the *Sail as-Saba'* flooded Seiyun on the seventh day of *Ramadhaan*. The flood reached its peak just before break-fast, at about 5 o'clock. Wadi Jethma was, at that time, undeveloped and filled with palm and *ja'abuur* trees. The watercourse filled with the uprooted trees and the water rushed through town, devastating even the market area, some distance from the watercourse. Many houses were destroyed, most of them by the watercourse. This flood is thought to have affected only Seiyun[28].

The Wadi Hadhramaut experienced a number of floods in the **1970s**, a change from the drought years of the 1960s. A report by Inter-Consult and Mott Macdonald on

flood protection for Shibam mentions a flood that hit Shibam in June 1974[29]. The consultants estimate that the flow reached 650 m^3/ s.

23 October 1977: in Shibam. Rainfall was widespread, especially over the South *Jol*. Wadis Du'aan and 'Amd discharged floods with an estimated peak of 800 m^3/ s[30]. Wadi Saar, only had a peak of 45 m^3/ s[31]. The south-west corner of Shibam's mud city wall was damaged[32], putting the houses behind the wall at risk from the subsequent ground movement.

Wadi	**date** month- year	**catchment area** km^2	**maximum observed** Q m^3/ s
Bin 'Ali (south)	4- 1977	720	200
Al- 'Ain (south)	10- 1977	1500	500
Maseila (Qasm) (central)	10- 1977	22500	975

Table 9: "Observed maximum flood peaks from existing literature", 1977[33]

1978: floods occurred at Shibam up to the city wall[34].

Wadi	**date** month- year	**catchment area** km^2	**maximum observed** Q m^3/ s
Thibi (north)	7- 1978	718	350

Table 10: "Observed maximum flood peaks from existing literature", 1978[35]

Wadi	**date** month- year	**catchment area** km^2	**maximum observed** Q m^3/ s
'Idm (south)	3- 1981	5485	1314
'Amd/ Du'aan (south)	3- 1981	6553	985

Table: 11:"Observed maximum flood peaks from existing literature", 1981[36]

The year **1982** brought heavy floods to most of the southern governorates. Worst hit were LaHej and Abyan where diversion structures and irrigation channels were destroyed[37]. Urban Wadi Hadhramaut was also badly stricken with damage to properties in Seiyun and Shibam. A report by SOGREAH, cited by Interconsult and Mott MacDonald, mentions two floods in 1982, a small one of an estimated peak at Shibam of 450 m^3/ s, and a larger one of 750 m^3/ s[38]. One of these floods occurred on the 30th of March[39], probably the larger of the two. Interconsult and Mott MacDonald themselves give only one flood, with a flow estimate of 850 m^3/s, also at Shibam[40].

30 March: floods in Shibam. Rain fell on the Muuza' diversion weir, 4 km from Shibam, and the town itself for 45 minutes. However, the flood originated in Wadi Sarr in the north-west where it had rained for 2 and a half to 3 hours, beginning a 16:30h in the afternoon[41]. The city wall of old Shibam was undermined by the floods, collapsing in some places[42]. Wadi Jethma flooded, broke a bund near the secondary school and flowed into the area called al-Gurn, causing the collapse of a few houses

In **1984**, both Tarim and Shibam were threatened by floods. The bridge under the main road to Shibam, built after the 1982 floods, had been constructed with closely-arranged concrete supports. Much of the damage to the irrigation channels was wrought by the backwash resulting from the blockage caused at the bridge by the debris and tree trunks carried by the flood waters[43]. Similarly, the Seiyun-Tarim road had been built across Wadi Thibi creating a dam for no outlets had been built under the road. Wadi Thibi flooded that year and was diverted by the blockage of the road up towards residential Tarim, inundating an area called MuHaidhara. Further disaster was averted when men blew the road up with dynamite[44].

Shibam also experienced a flood in **1987** with an estimated peak flow of 974 m^3/s[45].

Wadi	**date** month- year	**catchment area** km^2	**maximum observed** Q m^3/ s
Hadhramaut (Shibam) (central)	4- 1987	12800	974

Table 12: "Observed maximum flood peaks from existing literature", 1987[46]

The southern governorates again saw widespread flooding and destruction during a huge storm period in **1989**. Rain fell in the Wadi Hadhramaut for almost 24 hours beginning on the 19 March. The flood reached Shibam at 03:00h and peaked at an estimated 2400 m^3/s at 03:30h. The flood continued to flow for 24 hours[47]. Damage occurred to irrigation systems and flood defences, and a few houses built close to the watercourse in Shibam Sahiil collapsed. Four houses in Tarim were destroyed and many damaged when a series of flood bursts from Wadis ʿAidiid and Thibi coursed though an old channel in the quarter of MuHaidhara. The channel had been gradually been narrowed by house construction. One child was drowned[48]. Seiyun was also affected, but to a lesser extent than the other towns.

Wadi	**date** month- year	**catchment area** km^2	**maximum observed** Q m^3/s
Juʿayma (north)	3- 1989	760	559
Saar (north)	3- 1989	2540	2160

Table 13: "Observed maximum flood peaks from existing literature", 1989[49]

1992: reported by Interconsult and Mott MacDonald in Shibam. This was probably a small flood but, since the consultants were interviewing in 1992, the flood was fresh in the memory[50].

The floods of 1996

In June 1996, six governorates of the Republic of Yemen were hit by flash floods following five consecutive days of heavy rains that started on the 13th of the month. The intensity, duration and extent of these floods resulted in heavy material and economic losses, and over 320 deaths[51].

Damage	al-Jawf	Maarib	Shabwa	Hadhra-maut	Abyan	al-MaHra	Total
Deaths	4	186	120	12	2		324
Missing		105	3				108
Homeless families	1140	3480	7200	810	2390	5700	20720
Houses destroyed	129	1215	124	50	228	45	1791
Houses damaged	39	592	1150	70	320	470	2641

Table 14: Official estimates of Casualties and Household Losses, July 1996[52]

The worst afflicted areas were the populated areas that surround the Ramlat as-Sabatayn, in the governorates of Shabwa, al-Jawf and Maarib. The governorates of Abyan, Hadhramaut and the MaHra were less affected. Table 15 shows the governorates and valleys affected by the floods (not including data for al-MaHra which were unavailable).

Governorate	Major Wadi	Catchment km^2	Minor Wadi	Towns
al-Jawf	al-Jawf	14 000		al-Hazm
Shabwa	Mayfa'a Beihan Markha Hammam	8600 3600 3900 1850	Habbaan, Amaqin, Hada, Nahr, Kher, Dhura, Abadan	NiSSaab 'Ataq
Maarib	Adhana Hariib/ 'Ain	12600	al-Ghams, al-Juba, Wasif, al-Ghamis, Ablah, al- Haadi, Mablaga	Maarib
Hadhramaut	Hadhramaut Hajar Huwayra/ alMukalla catchment	21000 9300 5000	Sarr, Neir	Shibam Seiyun al-Mukalla as-Shihr
Abyan	Hassan Bana Ahwaar	3500 8000 6400		Lawdar

Table 15: Showing Wadis and Towns in the Governorates affected by the 1996 Floods[53]

On the 18th of June, an international appeal was launched by the Government of Yemen[54] requesting emergency assistance. Money and donations in kind came pouring in from the Arab world, Europe and North America and Asia amounting, according to a UN estimate, to a total value of over $US 10 million[55].

The Special Relief Operations Service (FAO) assessment said that the floods of 1996 were "surely the most severe that have been recorded in the recent past."[56]. The floods for the majority of the stricken governorates were the largest in living

memory, the report by the DNV estimated them to have a return period of more than two hundred years[57]. TNO gives an estimate of one hundred years. Maximum flow rates in several of the afflicted wadis could well have exceeded 3500 m3/ s [58]. A 15km lake of water was left by the floods in the desert plain of the Ramlat as-Sabatayn[59]. Table 16 gives some indication of the size and intensity of floods in individual valleys in the Shabwa and Maarib governorates, all of them draining into the Ramlat as-Sabatayn.

Wadi	Discharge (m^3/s)
Ablah Maarib	1200
Hariib Maarib	2400
Beihan Shabwa	1100
Markhah Shabwa	3700
Amaqin Shabwa	2900

Table 16: Showing estimated maximum flood flows in the Shabwa and Maarib regions, June 1996[60]

The floods devastated agricultural production in the stricken areas. In August, it was estimated that more than 13,300 hectares of agricultural land in the five governorates were destroyed by the floods[61]; topsoil and fields completely washed away to the value of $US 53 million (6.6 billion yr.). In addition, about 4000 ha of crop production for the year 1996 was lost. An estimated value to the loss of the gross income from crop production is $US 8.8 million or 1.1 billion yr.. More than 45,300 ha were endangered because flood protection structures and irrigation networks had been destroyed[62]. As a result of the destruction of protective structures and the networks, the land became more vulnerable to subsequent flooding and the crops sown on the remaining soil after the first flooding were left unprotected[63]. An estimated $US 180 million (or 22.5 billion yr.) worth of irrigation infrastructure and flood protection works were lost in the floods[i]. Table 17 shows the data available to the government in July 1996 on losses in the agricultural

[i] The economic valuations, made in August 1996 were based on statistics from the Agricultural Yearbook of Yemen and the Agricultral Credit Bank (FAO, 1996).

sector. The patchiness of the data can be attributed to the fact that not all the assessment missions had been to the field at that stage, and certainly had not been to all the affected areas.

Damage (in ha)	al-Jawf	Maarib	Shabwa	Hadhram -aut	Abyan	al-MaHra	Total
Eroded agricultural land							32000 over several governo rates
Agricultural land destroyed	1094			1186			2280
Agricultural land damaged				948			948
Agricultural land affected				153			153
Orchards destroyed		1431					1431
Orchards damaged		35					35
Orchards affected		191					191
Fruit trees destroyed	123	6450	24000	6717		240	37530

Table 17: Official estimates of Damage to the Agricultural Sector, July 1996[64].

Not only was agricultural land devastated by the floods, alternative agricultural sources were also affected. Many head of livestock were lost, and beehives were destroyed. MoHammed AHmed from Wadi 'Irma in Shabwa reported that 300 head of sheep had been lost by the beduin tribe living near the ancient, ruined city of Shabwa[65]. The loss of beehives resulted in a significant loss in revenue from the sale of the famous honey from wadis in Shabwa and the Wadi Hadhramaut, in particular from Wadis Jerdan and Du'aan. Bee-keepers were further disadvantaged as many of the trees from which the bees collect pollen were also taken by the flood. 'Ali, from Wadi Dhura in Shabwa, lost 250 hives of bees, each costing between 800 and 1500 yr.[66].

Damage	Al-Jawf	Marib	Shabwa	Hadhr-amaut	Abyan	Al-Mahra	Total
Livestock lost	350	1700	3550	651	6886	86	13223
Beehives destroyed			3570	40	2133		5743

Table 18: Official estimates of Livestock and Beehive Losses, July 1996[67]

Services and infrastructure were also badly damaged by the rains and the floods. For example, the ʿAusha well field, which supplies ʿAtaq and 12 villages in the area, was badly damaged. Of the four wells, three pumps were irreparable, the fourth well was completely washed away along with its engine house. Pipes were damaged for over 500m. ʿAtaq had no water in the city for the first day of the flood and for days after, people were dependant on private tankers selling water for 1500 yr. for 3000 litres. The power station in ʿAtaq was closed down after rain penetrated the control panel[68]. Many kilometres of road were washed away, mostly in the places where the road crossed a wadi bed.

Damage	al-Jawf	Maarib	Shabwa	Hadhra-maut	Abyan	al-MaHra	Total
Electric generators	3	6	12	4	4	5	34
Electricity transformers	1	1		1			3
Roads (km)	60	60	128	820			1068
Bridges	2	8	8	3			21
Productive installations	29	15	45	16		13	118
Medical centres and Hospitals		21	5	3	2	1	32
Educational establishments		27	4	2	3	2	38

Table19: Official estimates for Infrastructural Damage, July 1996[69]

The priority during the relief period of the emergency was to distribute shelter and foodstuffs as soon as possible. The Red Crescent and the Red Cross imported 272

metric tonnes of rice for distribution to about 22,600 people in the six governorates. The rice was distributed in 50 kg bags, enough to keep a family with no other resources alive for one month. This was designed to tide families over until alternative sources of money, and therefore buying power, could be found[70]. According to MuHammad Barakaat, who was involved in the supervision of the foodstuff distribution, people were unlikely to become dependant upon handouts since they also needed other goods, such as oil, wheat, meat and vegetables[71].

The emergency relief effort was headed by the Higher Relief Committee, itself headed by the Prime Minister. Within the governorates and districts there were further sub-committees. The governor and the local authorities were contacted by the distribution team to find out which areas were worst hit, so that the relief could be targeted to the most needy, although it was impossible to reach all of the many scattered communities[72]. On a certain day in each governorate, representatives from the Red Cross and the Red Crescent supervised the distribution of the rice. Due to the long process of pledge-giving, tendering and wrangling over contracts, the distribution took place almost a month after the floods[73].

As most of the population in the flood-damaged areas relied almost solely upon agriculture for their livelihood[74], the priority in the rehabililitation stage of the emergency was the repair of the irrigation networks and flood protection works essential to agricultural practices in the wadis[75]. Due to the extent of the damage, the reconstruction of these structures was recognised to be long-term as well as short-term aim. High on the agenda came the construction of gabion spurs and earth bunds, simple barriers erected to protect the remaining land and utilise the next rains to fall to their fullest extent[76]. Despite the fact that speed was emphasised, many areas I visited in Shabwa during March 1997 were still unprotected.

Rehabilitation for the agricultural sector was scheduled to take place over a longer time-scale. It was hoped that attempts could be made to integrate the aid with ongoing projects, preferably with some mitigation strategies built-in[77]. Co-operation with the farmers was important to many of the operations, both for economy, local expertise and the fact that the farmers had to maintain the new structures in the future. Farmers frequently made themselves available as labour for they were as keen, probably more so, as the government to rehabilitate their lands. The menfolk of the farming communities assisted in the rehabilitation of wells and laying pipes,

filling gabion crates and creating earthen bunds. In many cases, however, the communities started work for themselves, realising that to wait for aid and government intervention would benefit them nothing. This was a sensible move for, by the January 7, 1997, the Government still had not started much of their plan for rehabilitation[78]. By contrast, infrastructural damage was repaired quite quickly[79] as the the damage was limited, and the government already had the expertise, and administrative and maintenance facilities in the areas already.

Damage to the Wadi Hadhramaut

Of the six governorates affected by the floods of June 1996, the Hadhramaut was the least devastated. The districts of Seiyun (inland) and al-Mukalla (coastal) suffered the most damage[80]. According to the residents in the Wadi Hadhramaut, the floods had not been of the same magnitude as those in Shabwa and Maarib, a fact borne out by the catalogue of losses. Neither were the floods as destructive as previous floods that had rushed down the valleys, for instance the floods of 1982 and 1989. The comparatively small floods that the Wadi Hadhramaut are the result of lower levels of rainfall as shown in table 20. Some reduction in losses can also be attributed to the fact that the Wadi Hadhramaut is wider and more level than the valleys that flow into the Ramlat as-Sabatayn. A wide, shallow valley like the Wadi Hadhramaut has more available land for agriculture and settlement, so that encroachment of the watercourse less unnecessary. In addition, in such a valley the flood waters run more slowly, therefore reducing destructive erosion.

Station	**Rainfall 14-18 June 1996 mm**	**Total Rainfall June 1996 mm**
Sanaʿa', capital in the western massif	47.2	164
Maarib	135.0	189
Seiyun, Wadi Hadhramaut	**7.0**	**74**
Riyan, coastal Hadhramaut	54.5	64.3
ʿAtaq, Shabwa	64.5	~

Table20: Rainfall, June 1996[81]

It can be clearly seen from table 19, that the Wadi Hadhramaut received considerably less rain than the other governorates, although still 8.8 mm more than the average annual precipitation of 65.2 mm[82].

Shibam was really the only town to be affected by the floods, situated as it is on the confluence of Wadis Saar, ʿAmd, Duʿaan and al-ʿAin. The unofficial *Shibaami* measure of a large flood is whether a flood reaches the *suur*, the city wall of the old city of Shibam. In 1996, the flood touched the *suur* and flooded the ground floors of the shops and cafes just outside the walls[83]. In Shibam SaHiil, three houses were completely ruined by the flood waters, twenty houses were damaged, probably by rainfall[84]. The wadis through the towns of Seiyun and Tarim did not carry significant flood flows. A number of houses in Seiyun collapsed as a result of heavy rainfall.

The main damage in the Wadi Hadhramaut, as for the other governorates, was to the agricultural sector. Estimates of agricultural losses were reported as: 310 ha of destroyed land, 450 ha of crop loss, and 2600 ha of land endangered by further floods[ii]. Much of the 1996 date palm and fruit tree crop, the leader crop in income generation, were lost[85]. The rains had come at the most vulnerable time of fruit growth, when the dates were almost ripe. It is frequent practice to tie woven palm bags around the bunch of dates once they get to a certain size in order to protect the bunches from the wind. If it rains while the dates are in these basket bags, the bunches rot and are ruined[86]. Estimated values to the agricultural losses in the Wadi Hadhramaut are given in table 21.

[ii] Another estimate, farmers lost 1625 ha.s of crops/ 1405 topsoil// 4700 + ha.s endangered land (FAO, 1996)

Table showing distribution of crop loss

crops	crop distribution, %	gross income, yr./ha.	affected land distribution, ha.	value, yr.
cereals	47	40 600	1424	578 184 60
vegeta-bles	5	32 000	152	4848000
fruit	34	114 000	1030	1 174 428 00
fodder	12	51 000	364	18 543 600
cash crops	2	50 000	61	303 0000
total	100		3030	201 682 860

Loss incurred	Value of loss, yr.
Date palms, mostly in Tarim	15,745,000
Rain-damaged dates	25,308,000
Fruit trees, eg.papaya	4,220,500
Wheat	2,145,000
Other crops	355,000
Topsoil taken from agricultural land, (Seiyun, al-Qatn, al-HawTa, Tarim, Sawm- east of Tarim, Bir ʿAli- near al-Mukalla)	26,550,000
Bee hives	3,750,000
Wells and Pumps	22,000
Earth bunds	16,500,000
Destruction of WHAP installed flood defences in Juʿaydi village, Wadi Saar	85,860,000
Equipment belonging to WHAP stored near Wadi Saar project	6,227,250
Total losses in al-Qatn area only	45,000, 000

Table 21: Agricultural losses in the Wadi Hadhramaut, 1996[87]

Major damage occurred to the diversion wier, the Muuzaʿ, and irrigation network above the town of Shibam. The mud bund, which is designed to breach in large floods, was broken in waters that at times overtopped the highest point of the Muuzaʿ (3 1/2 meters high)[88]. The Sik, the final weir above Shibam was breached. The stonelined canal which used to take the diverted waters to the palm groves to the north and west of the town was also badly scoured. Originally one metre wide, the floods of 1996 had deepened it to such an extent that a doubledecker bus could have secretly driven down the channel, if it had four-wheel drive[89].

The Wadi Hadhramaut Agricultural Project is the implementing agency for World Bank and Arab Fund projects, based in Seiyun. WHAP was given the responsibility for the repair of the damage incurred by the agricultural sector, the responsibility to be worked out in the form of expertise to the government on road repairs and the repairs of the Muuzaʿ network[90]. WHAP was assigned to assist, within its financial capacity (US$ 500,000), the redevelopment of spate irrigation and the rehabilitation of the worst damaged and most important structures[91]. Priority was given to flood

protection structures and irrigation channels, followed by the supply of fruit tree and date palm seedlings to those farmers who had lost their orchards[92].

The power supply of both Shibam and Seiyun, and Shibam's water supply were disrupted by the flooding and the rains. In Seiyun, overhead transmission poles were washed away or broken, of which some were retrieved and restored. Temporary measures had been completed by the time the assessment mission came on 5 July[93]. The estimate of the costs to repair the power station and reinstate the poles was US$ 4,500, a donor gave the money and the government installed the equipment[94]. Lengths of piping in Shibam's water system were washed away and the motors of its two submersible pumps were wrecked by the low voltage during the storm[95]. The cost of repair to Shibam's water supply was US$ 12,000. Again, a donor provided the money and the government implemented the installation through the Seiyun branch of the National Water and Sanitation Authority[96].

Some emergency aid was distributed in the Wadi Hadhramaut, for example; blankets, tents and food. The deputy head of the *Mudiriyya* asked for the commodities to be given to the sheikhs for further distribution. He was busy and did not know who was in need of the aid, the sheikhs did[97]. Two committees were established, one for assessing the damage to the agricultural sector, the other to the housing sector. The agricultural committee met two or three times to discuss the issues, and went to photograph the destruction[98]. After reports had been submitted, both groups met to talk. The committees, according to one of the members, did not actually do anything[99].

1997: At the beginning of March, two wiers in Wadis ʿAidiid and Gataba broke in a flash flood following a 15 minutes rainstorm over Tarim. As a result, flood waters rose over the banks of the ʿAidiid channel and threatened houses with destruction. Fortunately, only damage was incurred. During the same rainstorm, houses in the ʿAidiid area were also threatened by ~~the~~ a change in course of the small ʿAjaawiz channel.

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[88] 'Ali 'A. al-BaHbuuH, 18/1/97
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Appendix 2:

Rainfall data from selected stations in the Wadi Hadhramaut.

These tables corroborate the existence of two rainy seasons. They also show the spottiness of the rainfall since the levels of rainfall in neighbouring towns do not always correspond. Although daily records are not shown, it may be assumed from the nature of rainfall in the area, that each month represents one rainstorm. Therefore, a full year's quota of rain can often fall in one rain event. Records for the year 1994 seem to have been disrupted by the 1994 civil war.

List of charts:

chart 35: Qasm, 1995

chart 34: ʿAmd, 1995

chart 36: Shibam, 1995

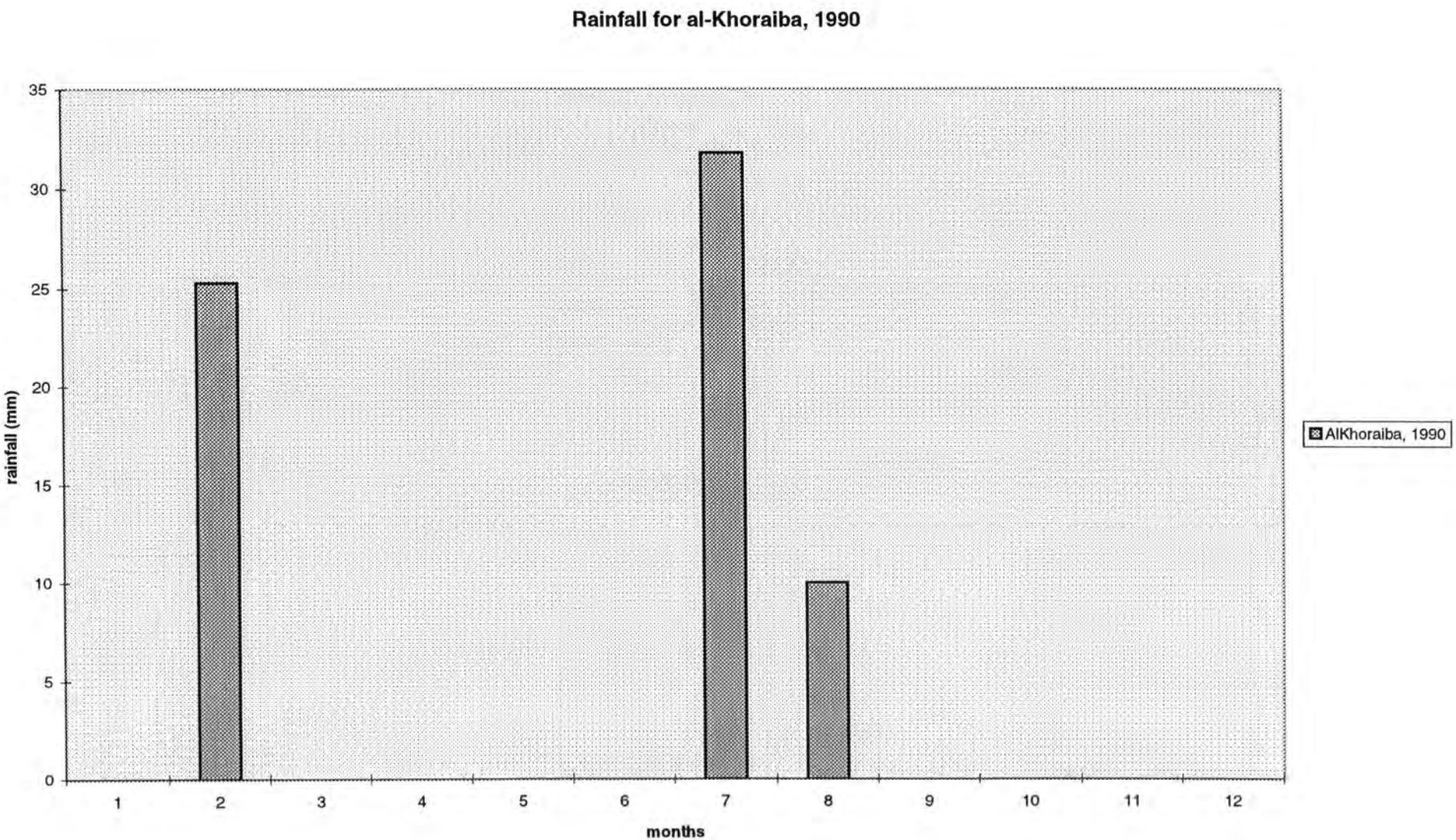
chart 38: al-Khoraiba, 1996

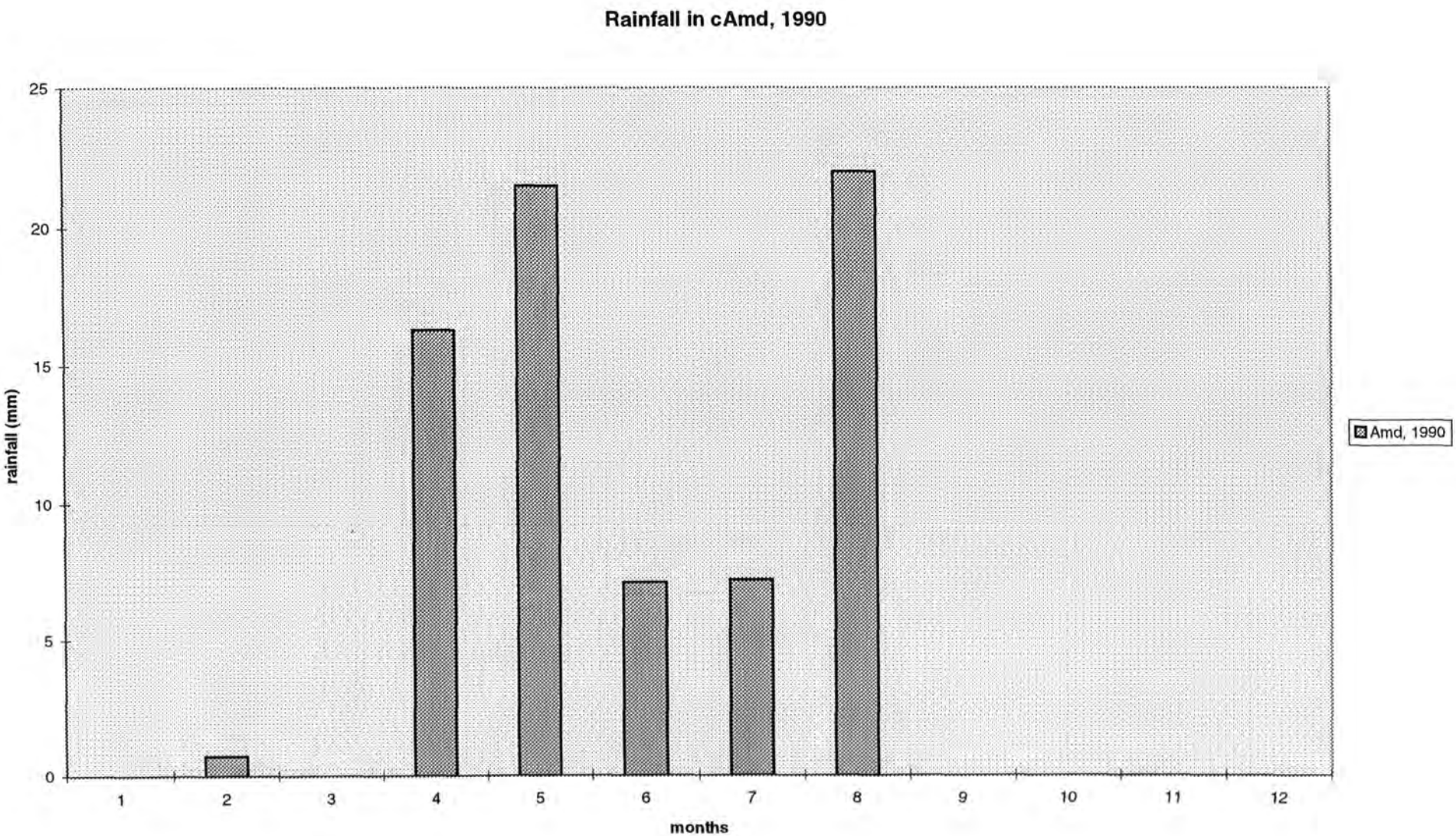
chart 37: Qasm, 1996

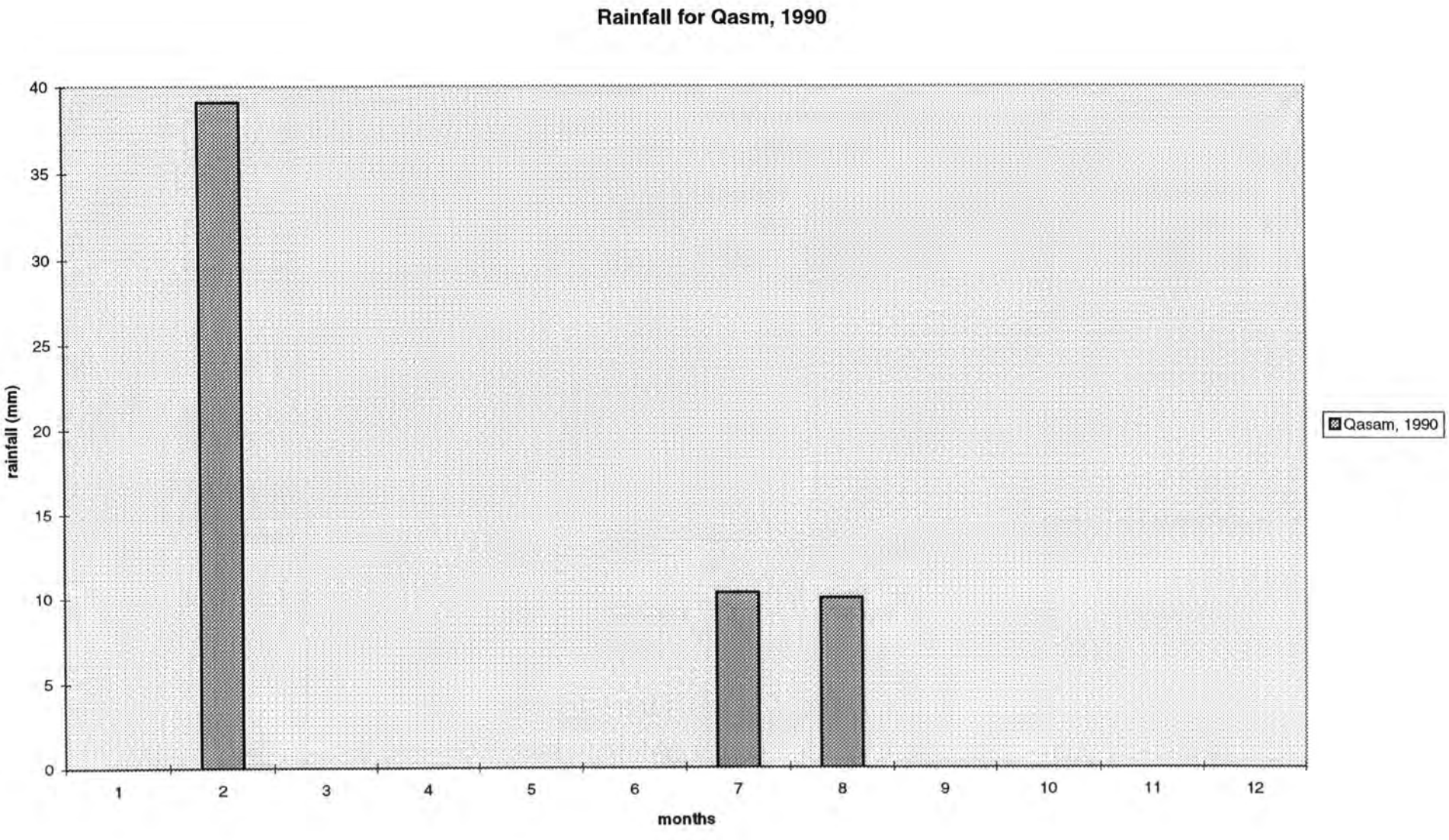
Sources: For data on Seiyun; the meteorological office at Seiyun Airport

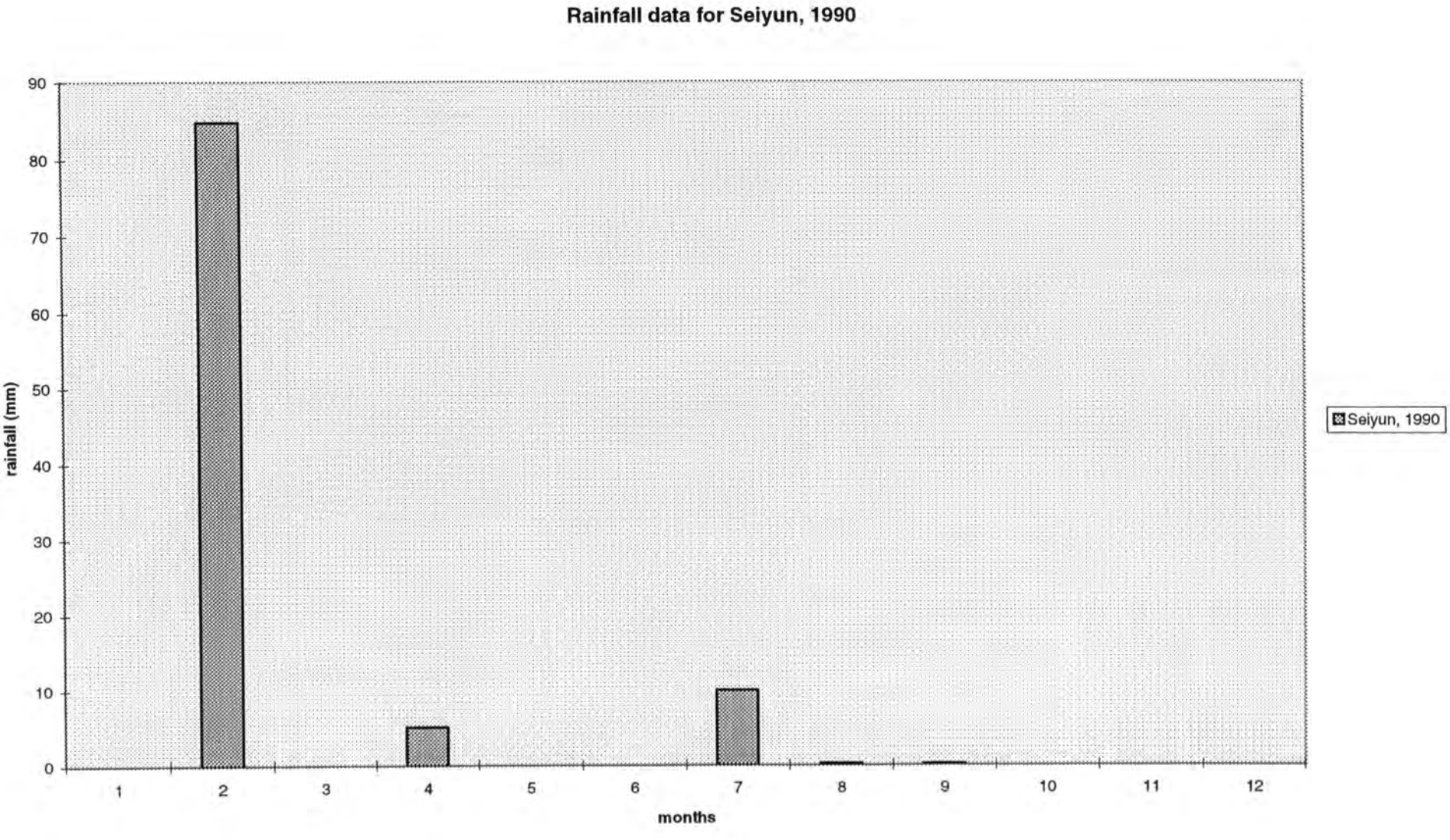
For data from other stations; Wadi Hadhramaut Agricultural Project.

Sheet1 Chart 15




Rainfall in cAmd, 1990
rainfall (mm)
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
months
Amd, 1990


Rainfall for Qasm, 1990
rainfall (mm)
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
months
Qasam, 1990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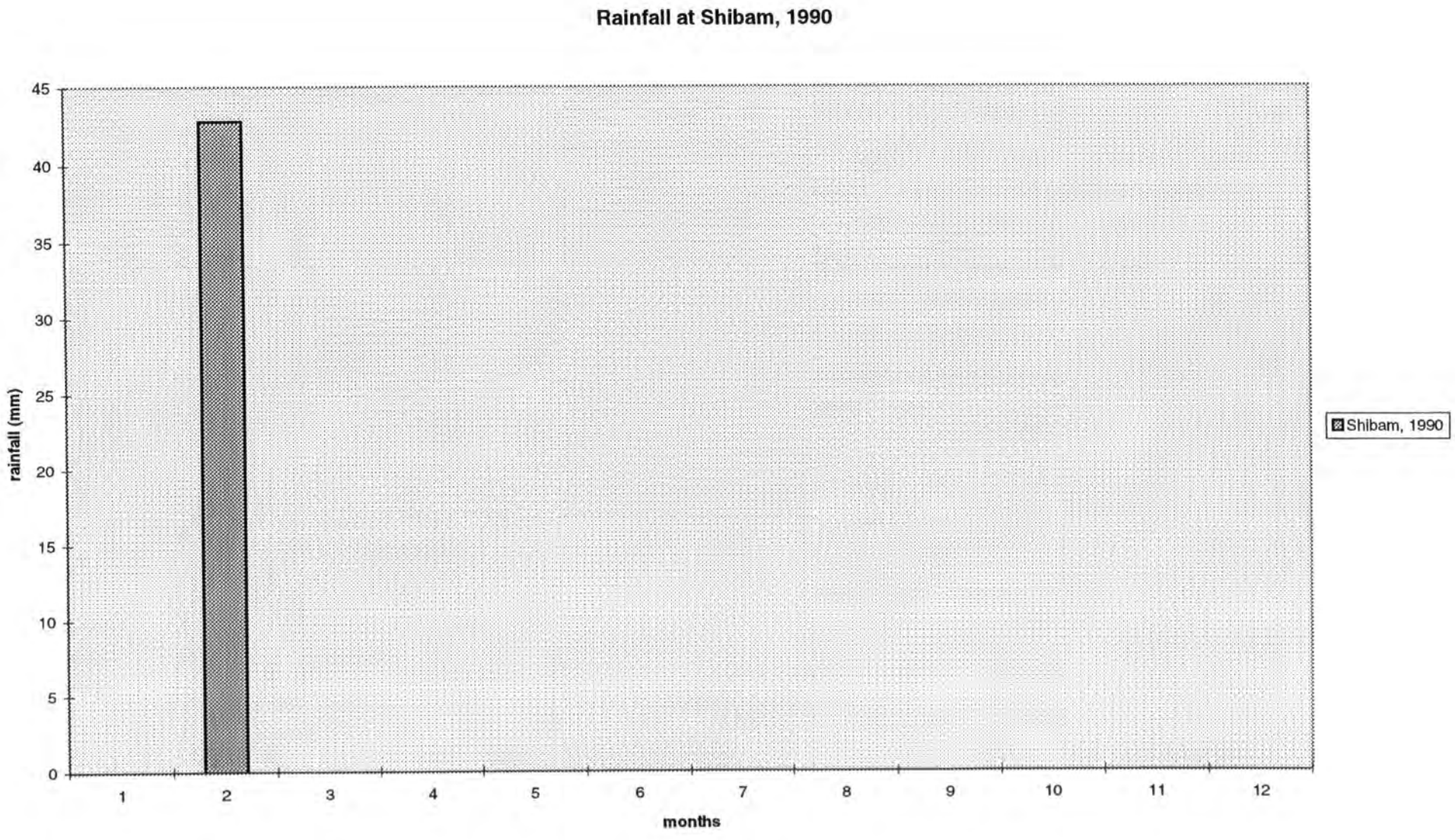
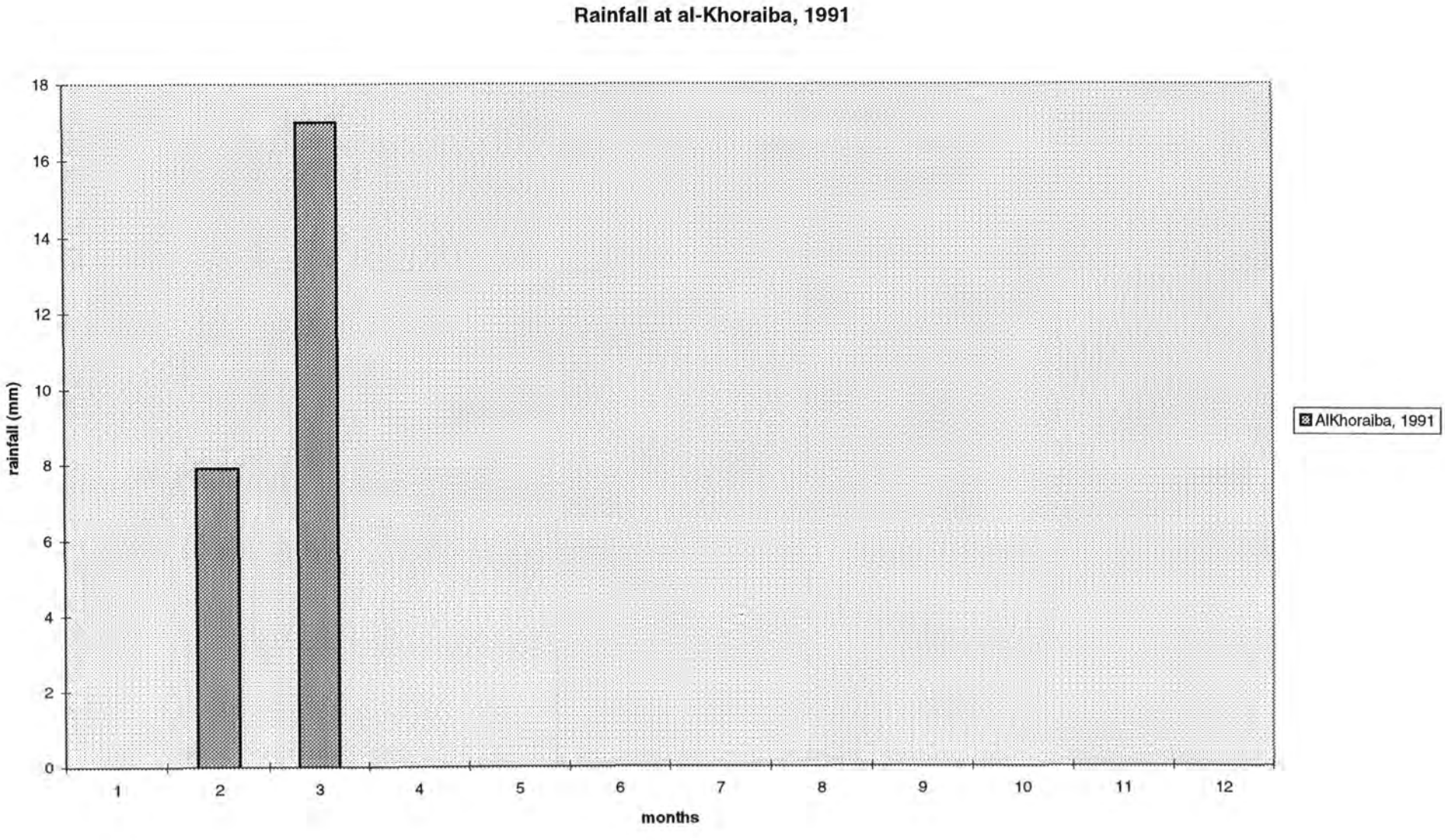
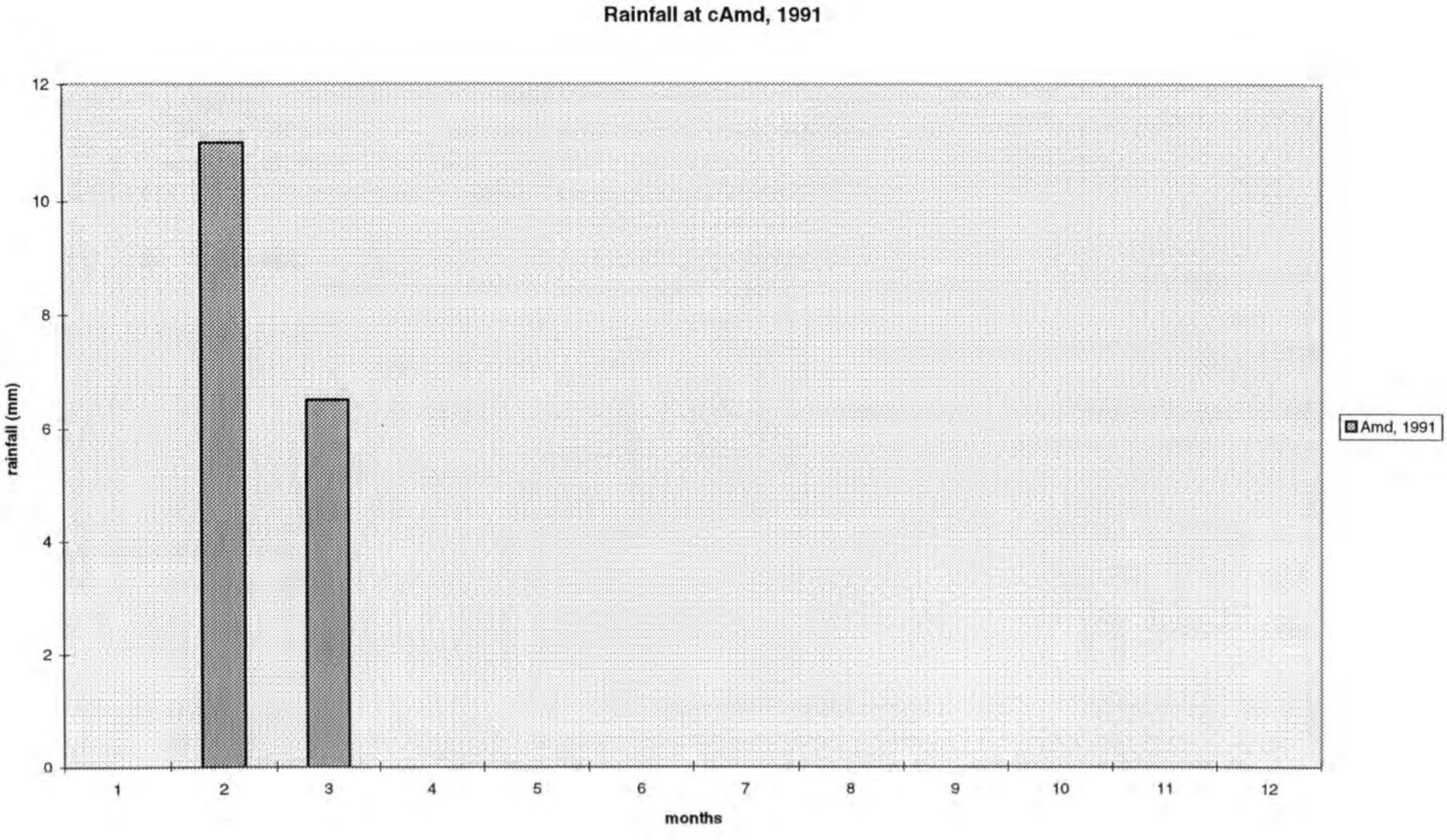
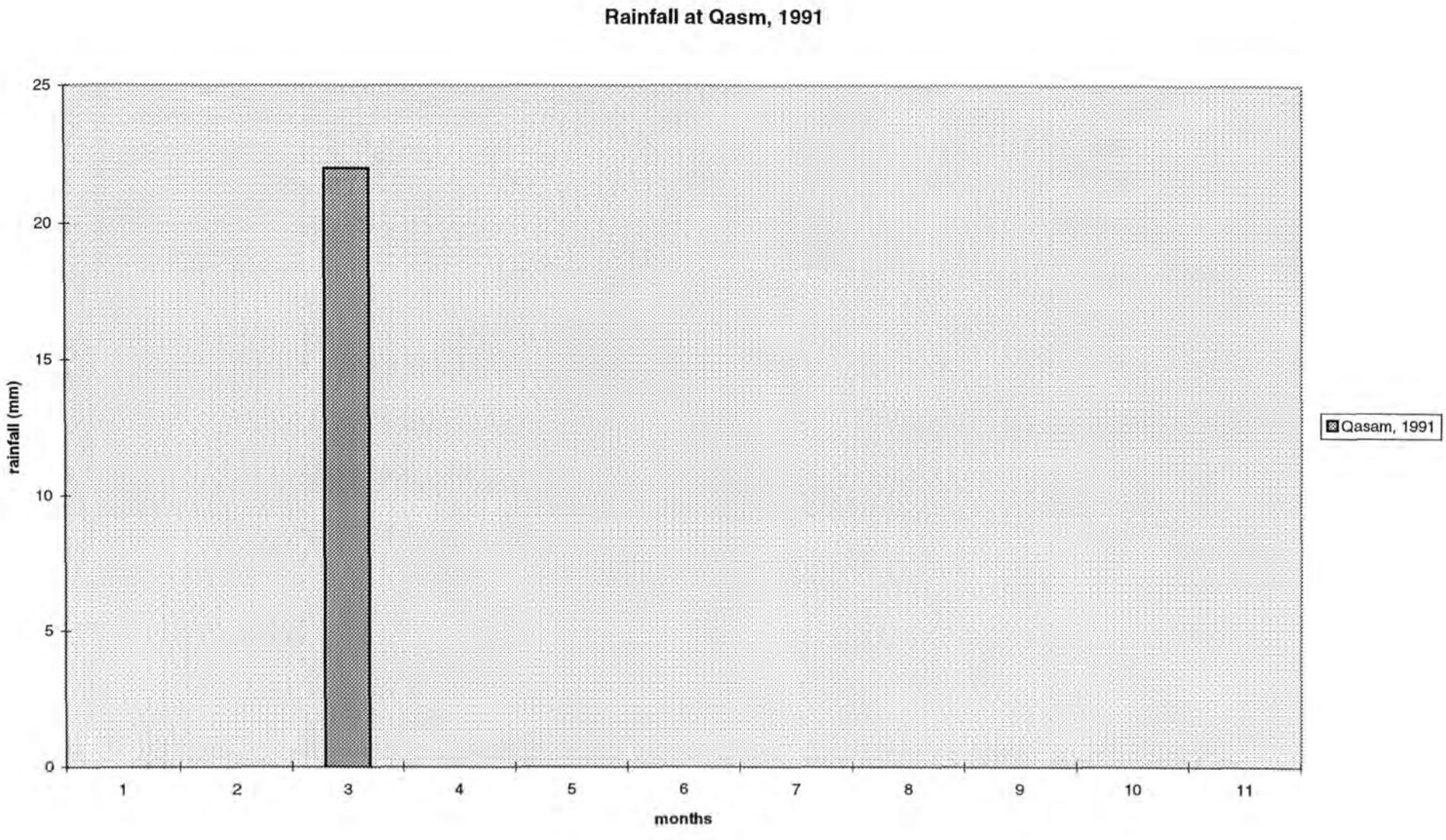
rainfall (mm)
0
10
20
30
40
50
60
70
80
90
1
2
3
4
5
6
7
8
9
10
11
12
months
Seiyun, 1990

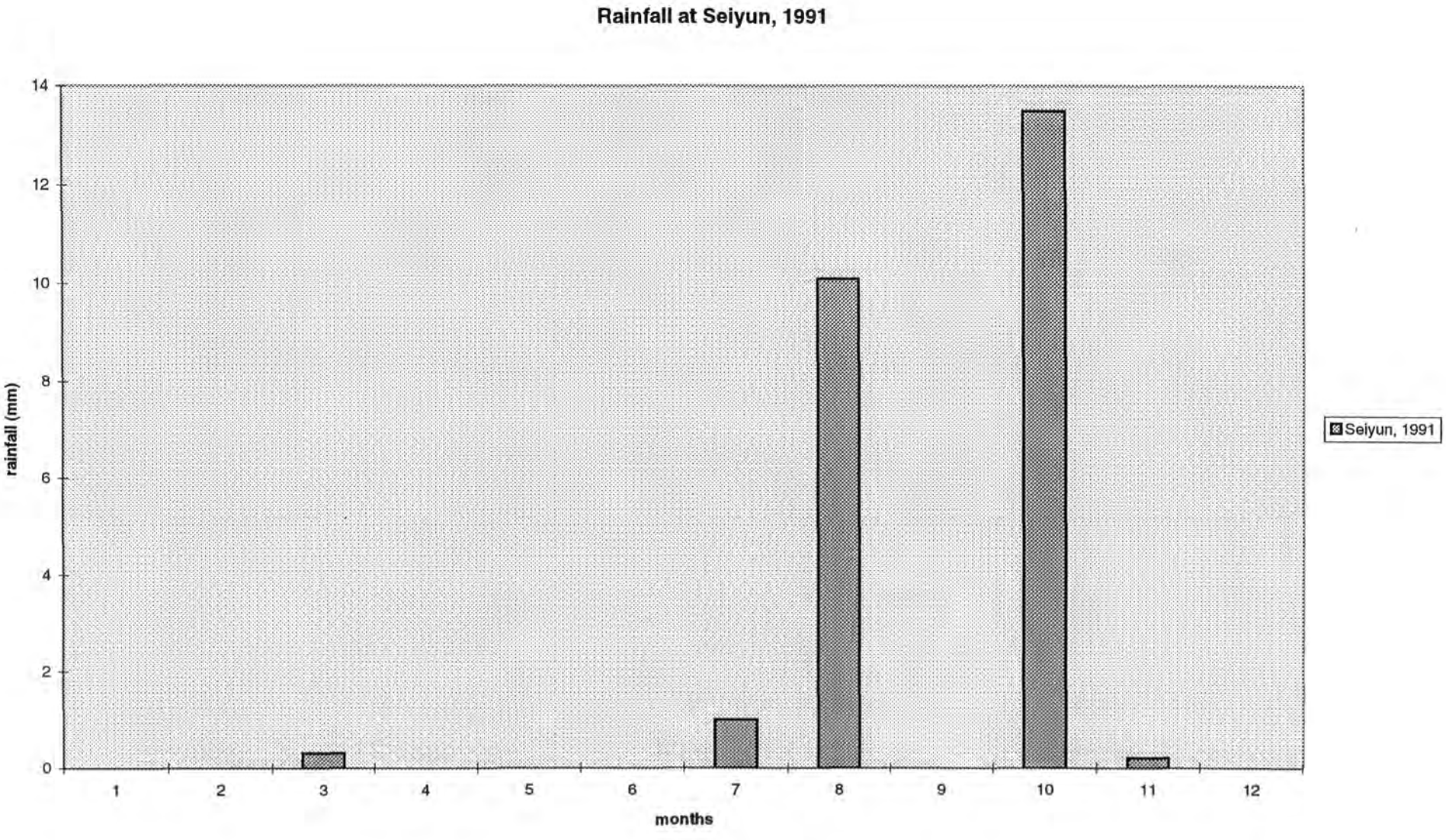

Rainfall at Shibam, 1990
rainfall (mm)
45
40
35
30
25
20
15
10
5
0
1
2
3
4
5
6
7
8
9
10
11
12
months
Shibam, 1990

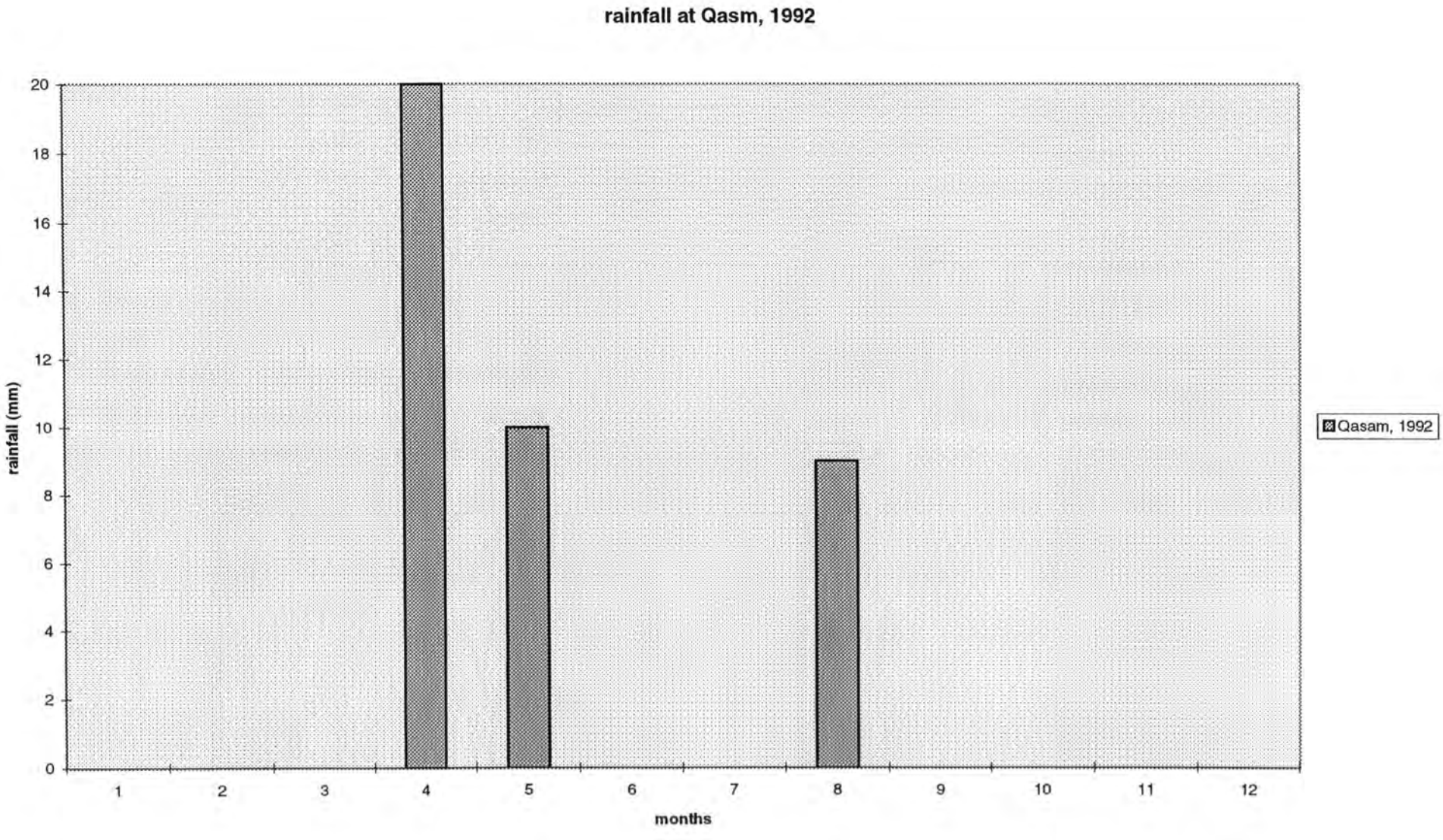

Rainfall at al-Khoraiba, 1991
rainfall (mm)
0
2
4
6
8
10
12
14
16
18
1
2
3
4
5
6
7
8
9
10
11
12
months
AlKhoraiba, 1991


Rainfall at cAmd, 1991
rainfall (mm)
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
9
10
11
12
months
Amd, 1991


Rainfall at Qasm, 1991
25
20
15
10
5
0
rainfall (mm)
1
2
3
4
5
6
7
8
9
10
11
months
Qasam, 1991

Sheet1 Chart 42

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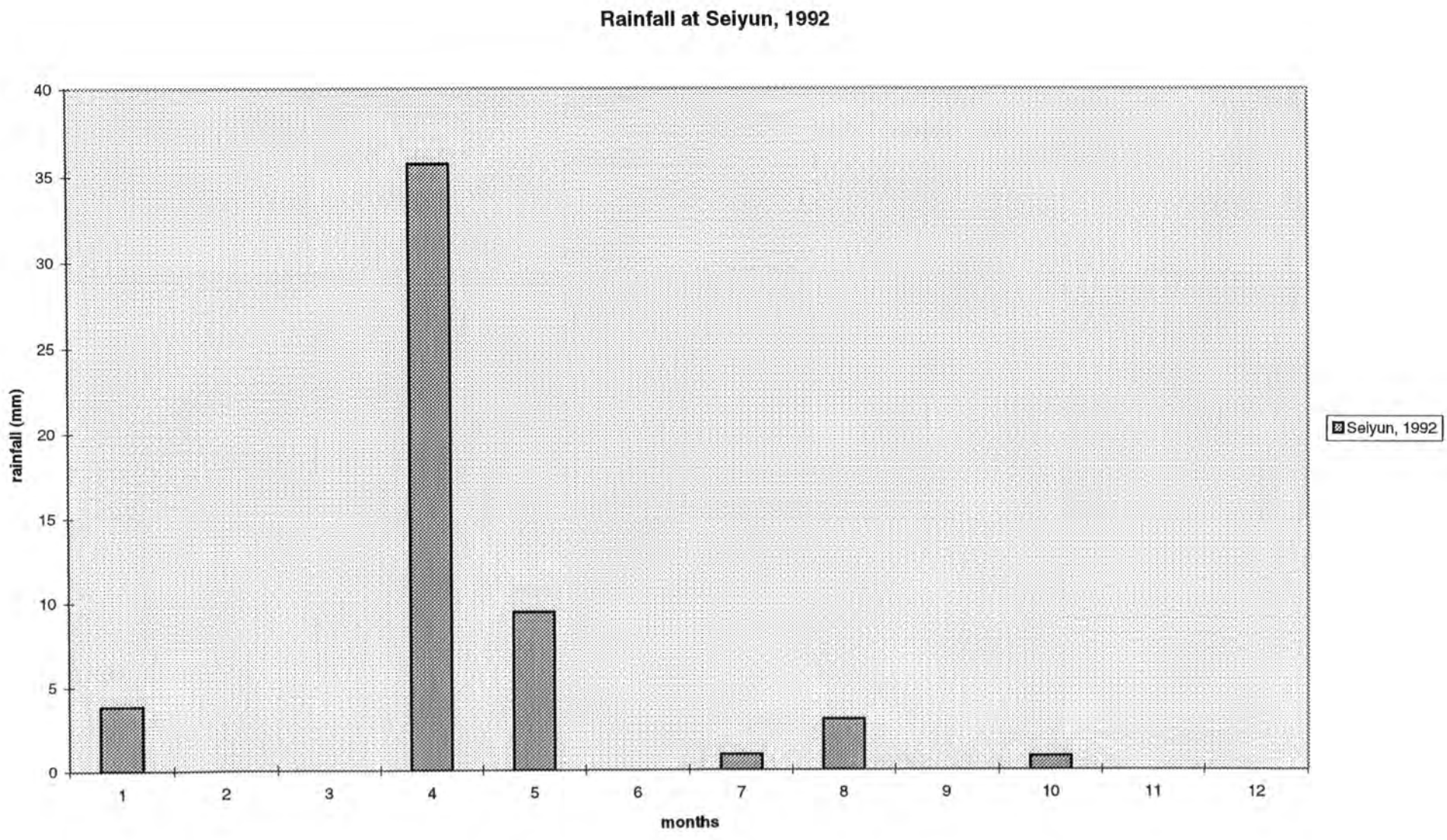
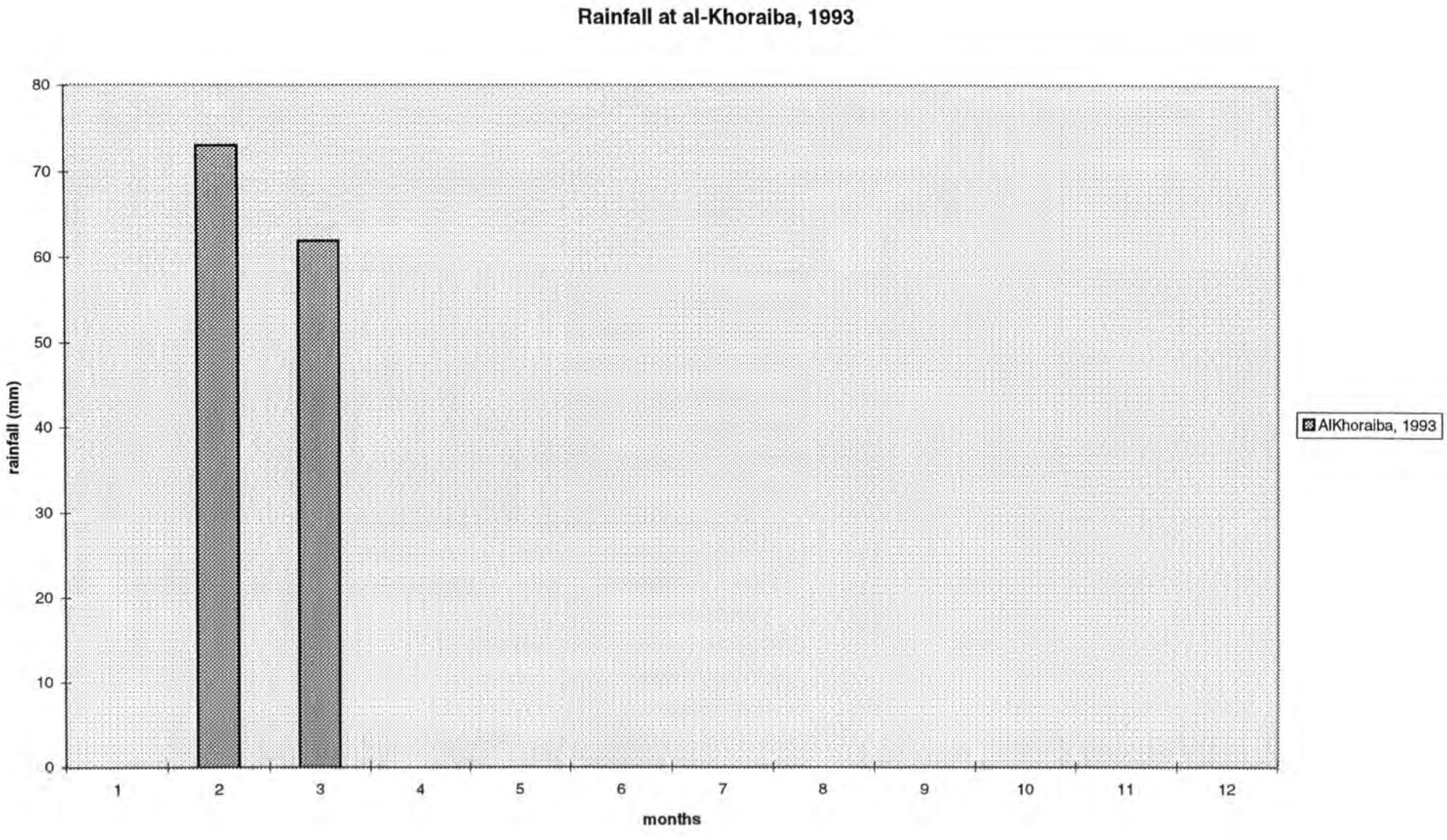
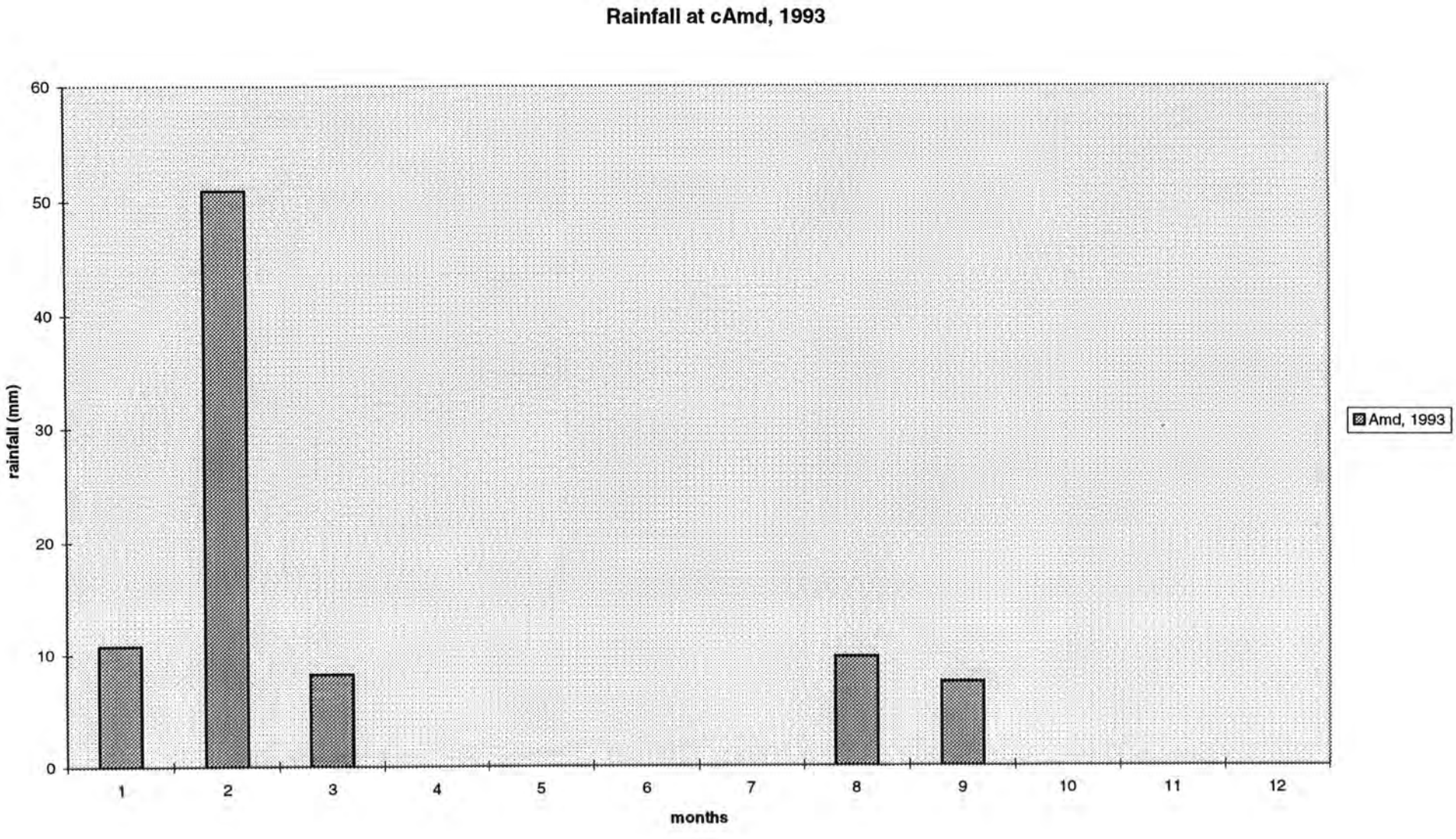
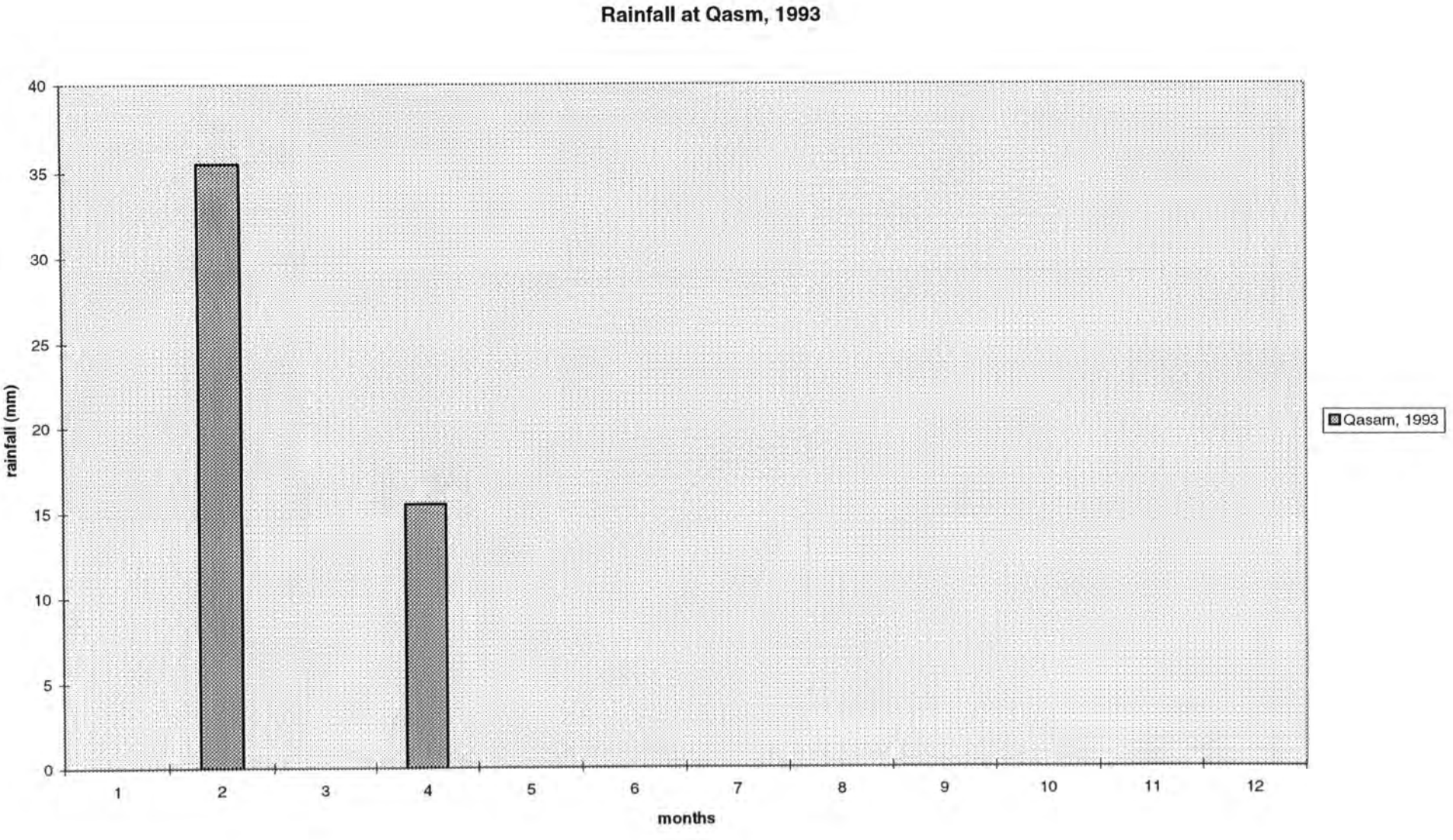
rainfall (mm)
0
2
4
6
8
10
12
14
16
18
20
1
2
3
4
5
6
7
8
9
10
11
12
months
Qasam, 1992

Sheet1 Chart 41

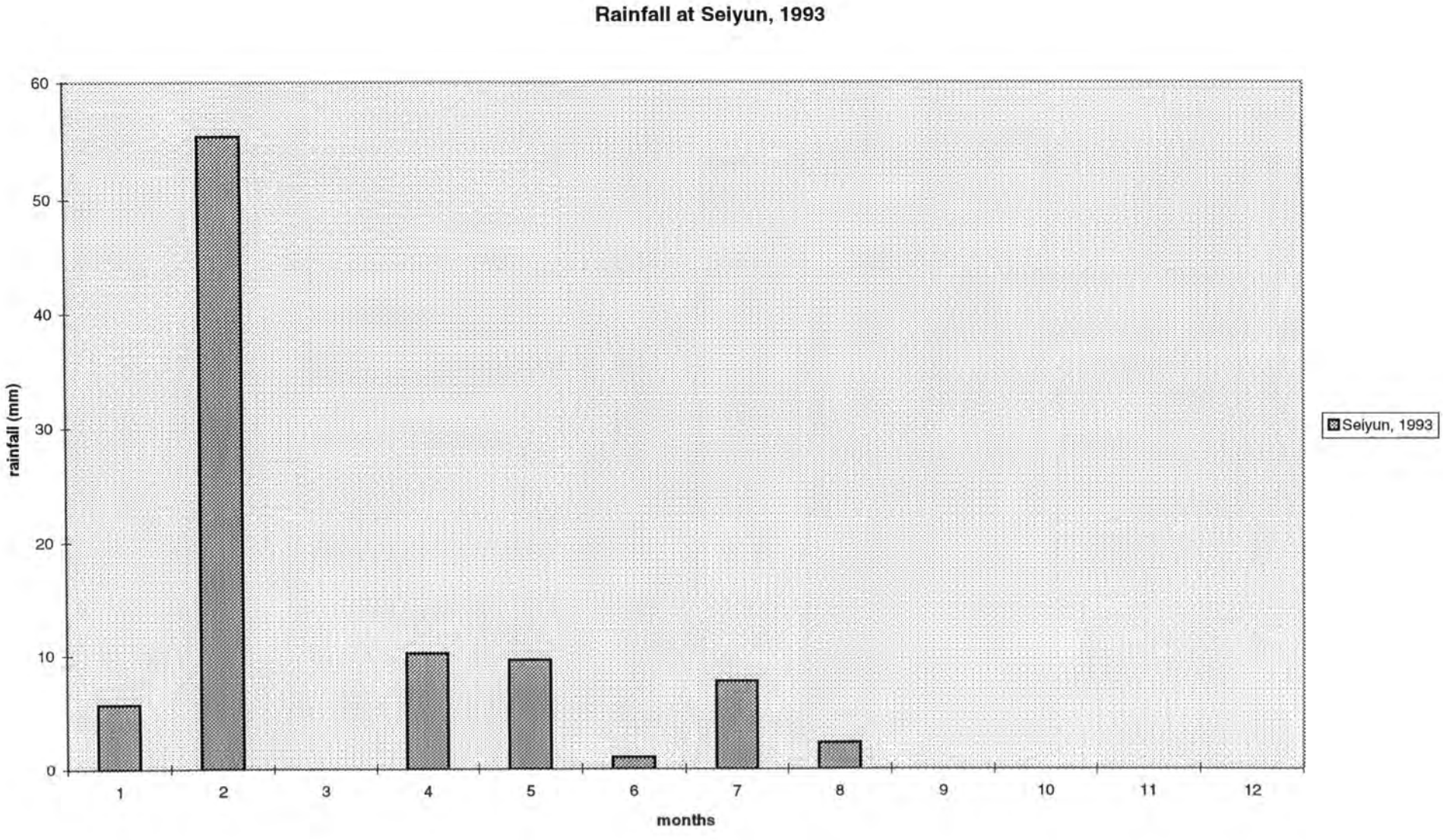


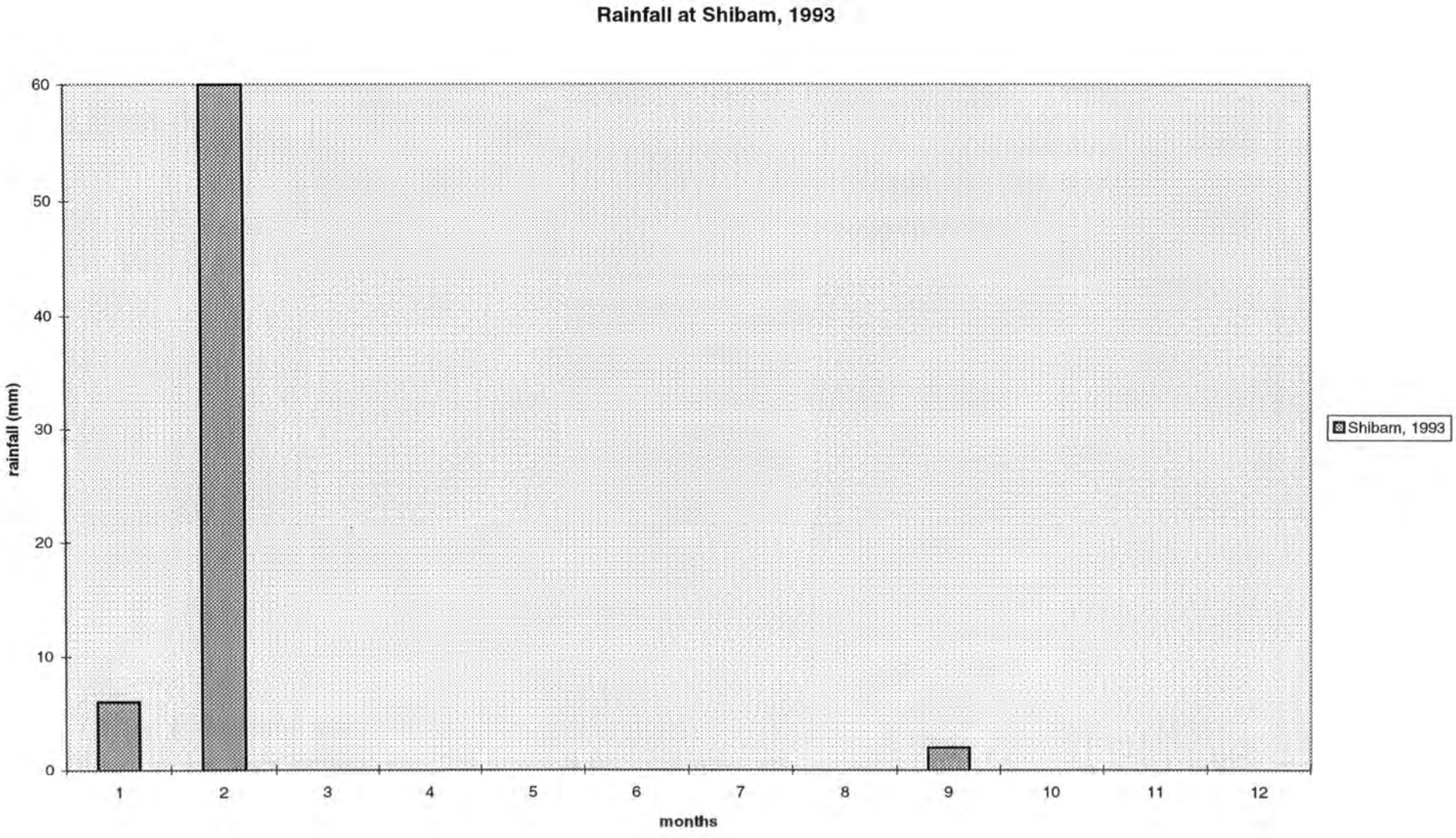

Rainfall at al-Khoraiba, 1993
rainfall (mm)
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
11
12
months
AlKhoraiba, 1993

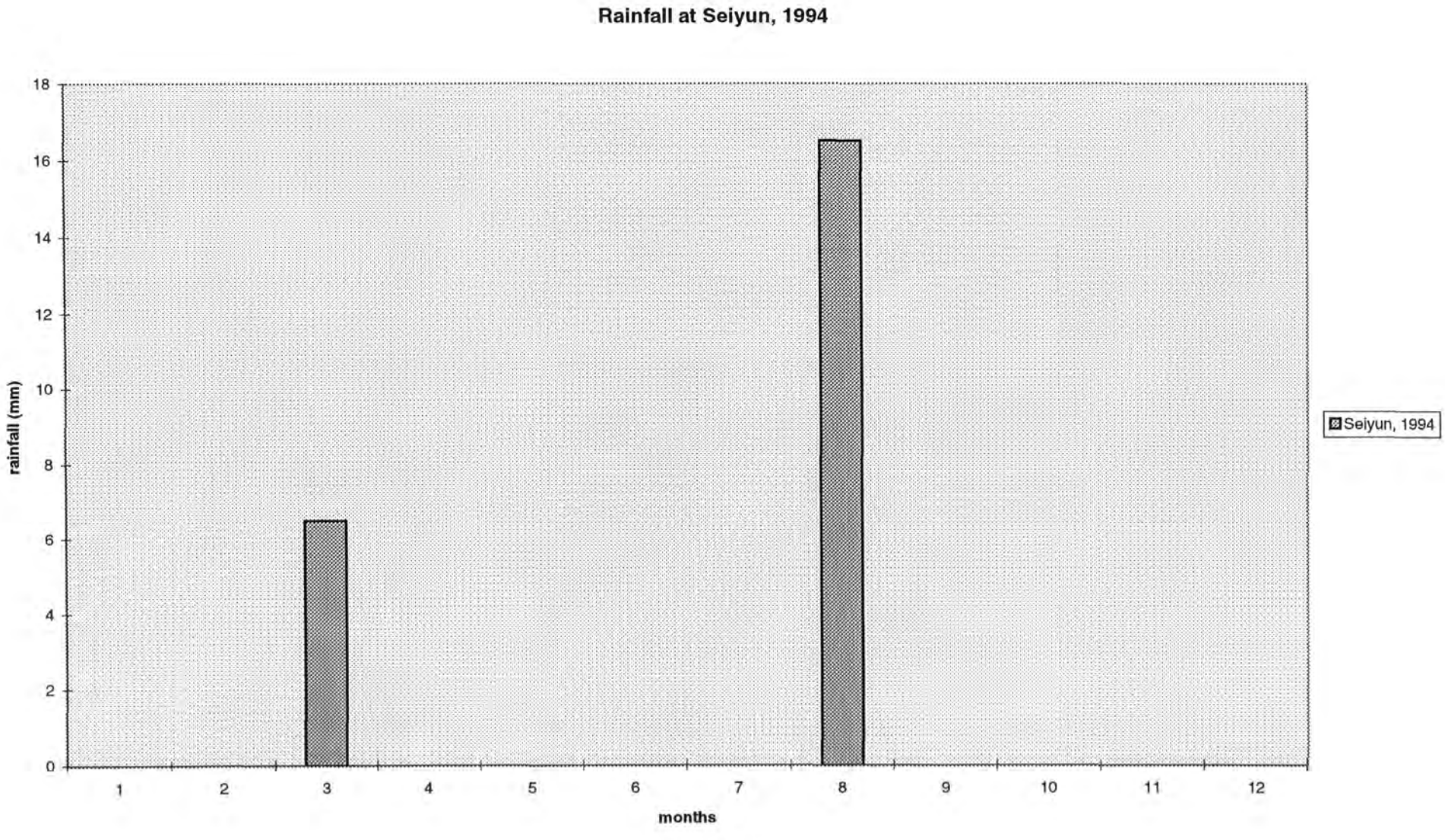

Rainfall at cAmd, 1993
rainfall (mm)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
months
Amd, 1993

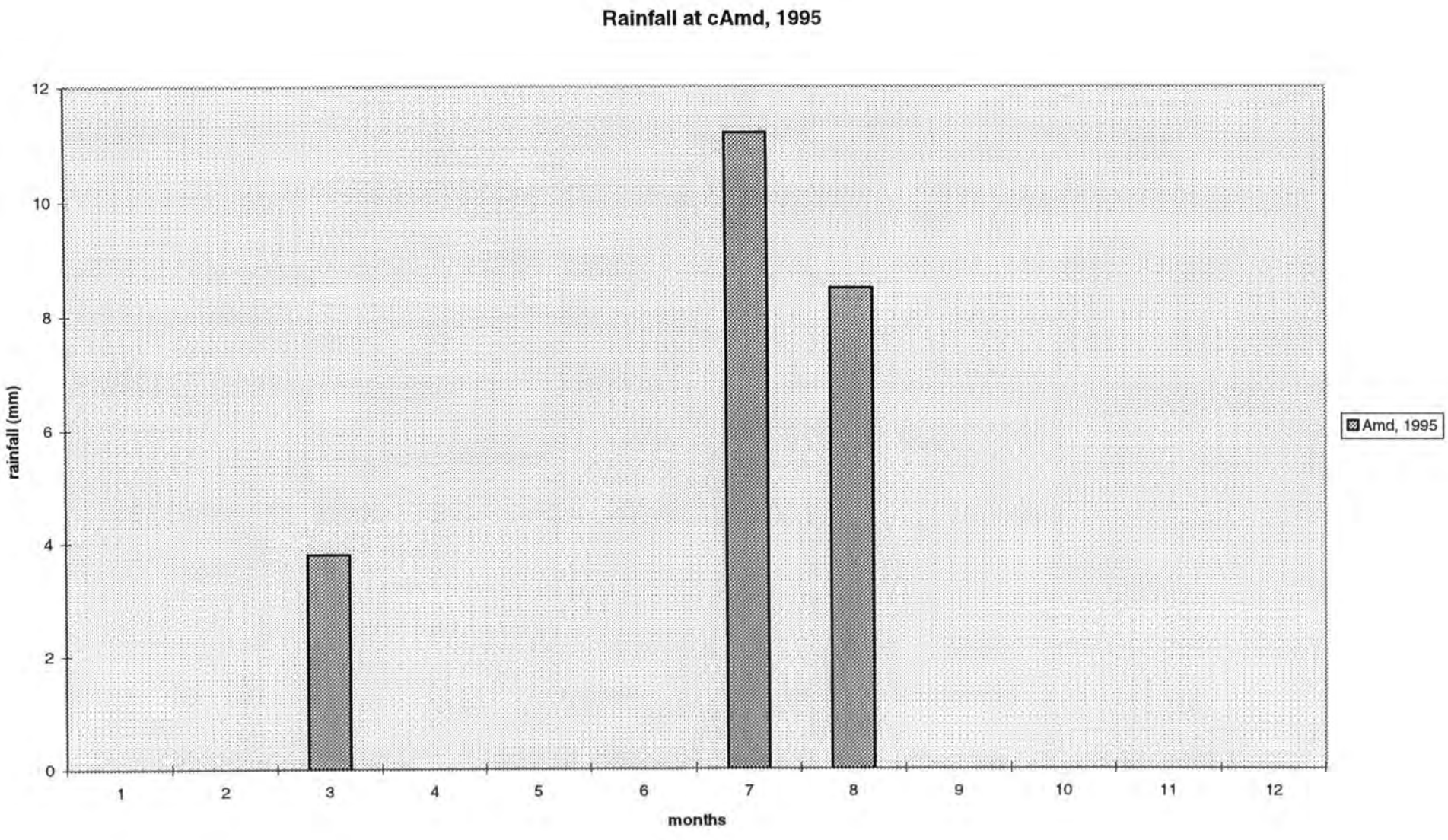

Rainfall at Qasm, 1993
rainfall (mm)
0
5
10
15
20
25
30
35
40
1
2
3
4
5
6
7
8
9
10
11
12
months
Qasam, 1993

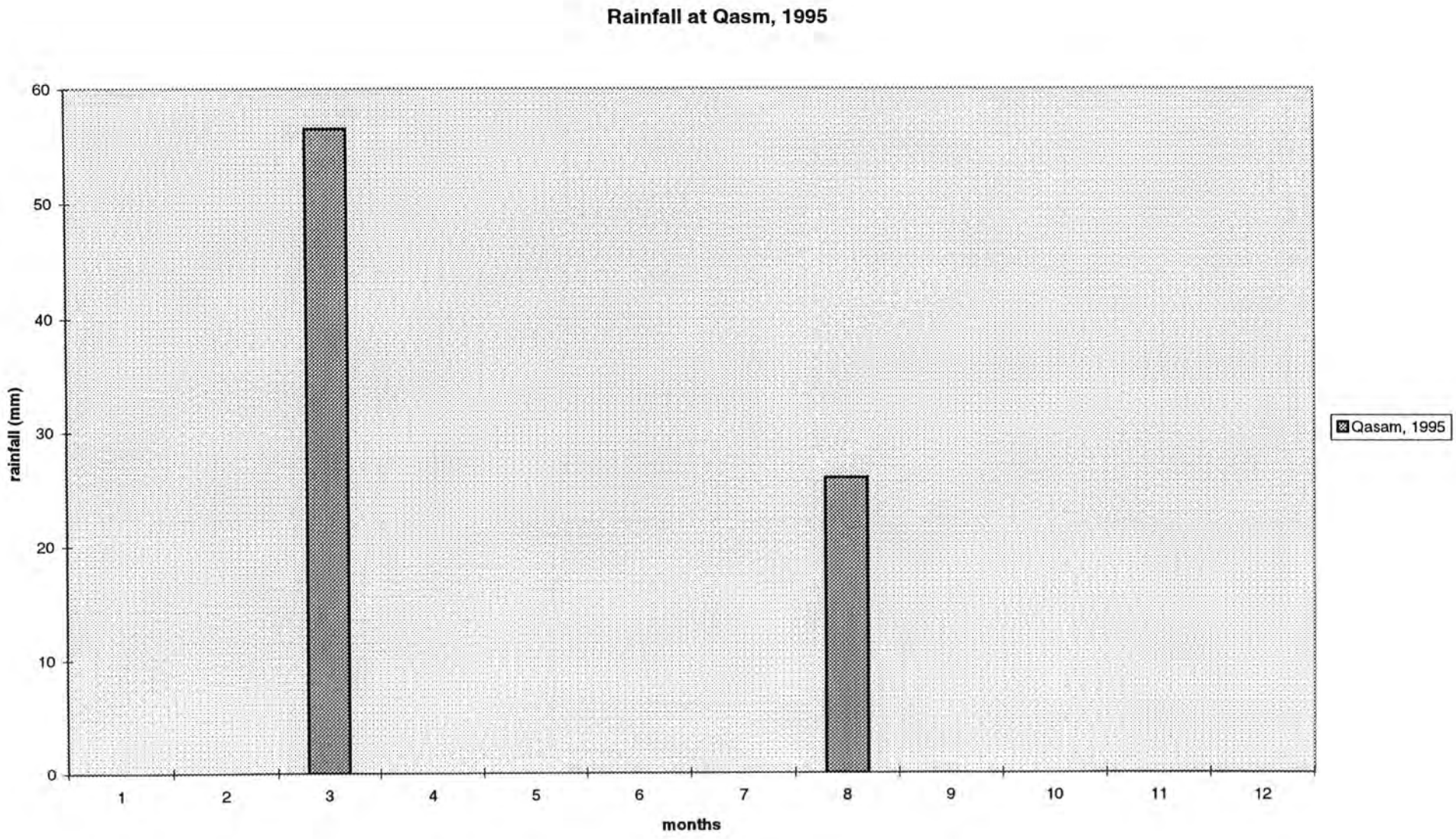
Sheet1 Chart 40

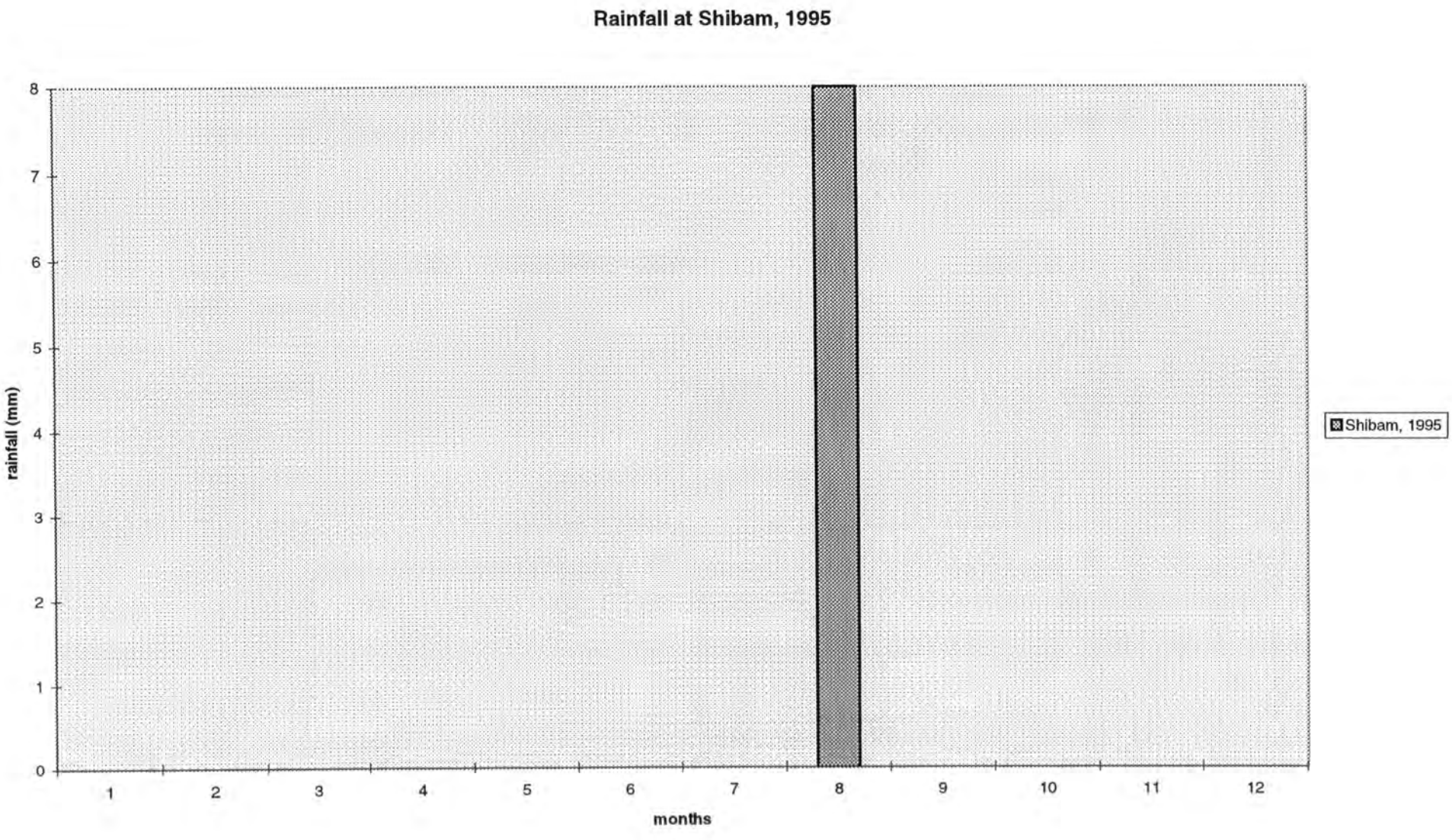



Rainfall at Shibam, 1993
rainfall (mm)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
months
Shibam, 1993

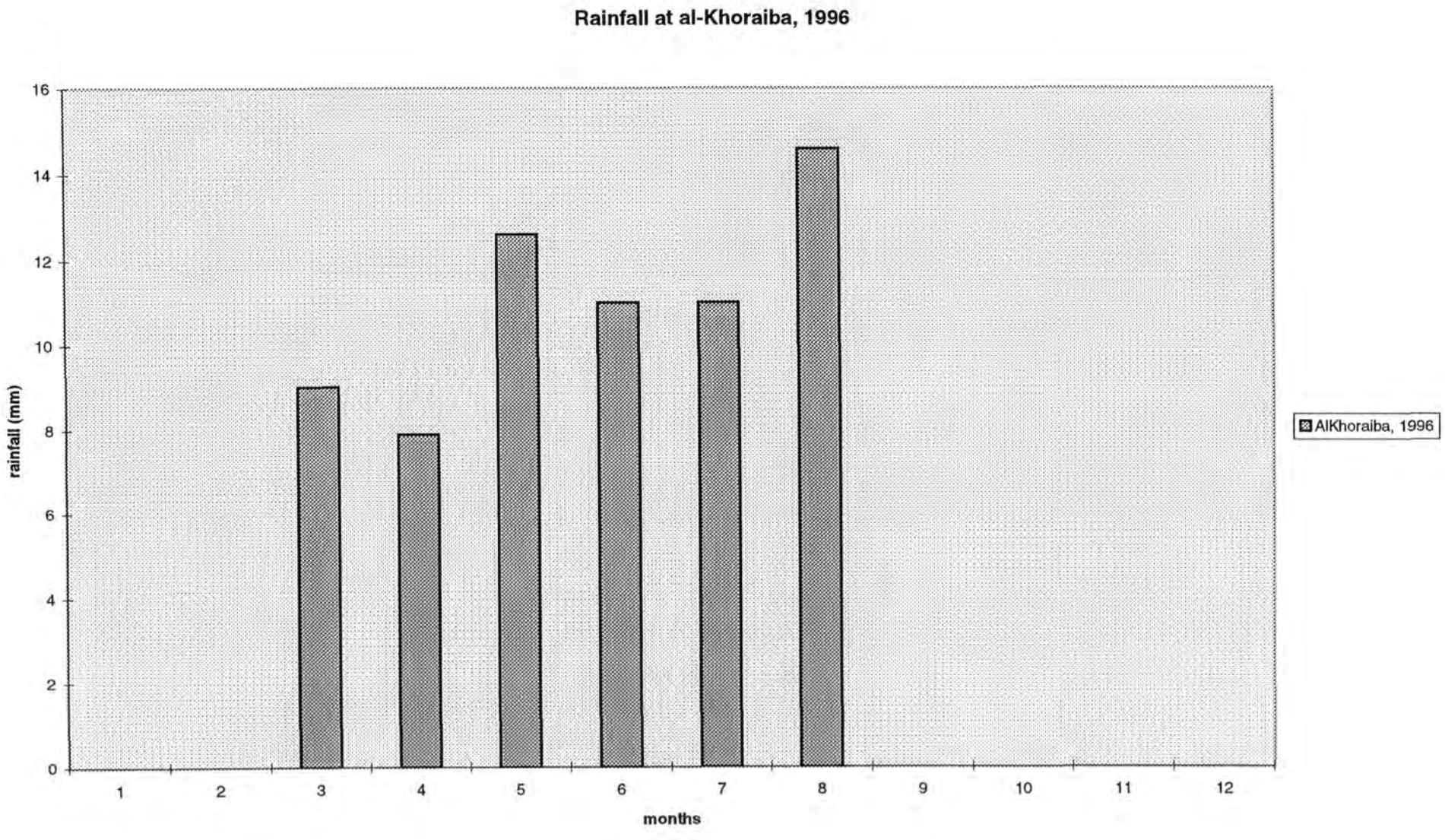

Rainfall at Seiyun, 1994
rainfall (mm)
0
2
4
6
8
10
12
14
16
18
1
2
3
4
5
6
7
8
9
10
11
12
months
Seiyun, 1994


Rainfall at cAmd, 1995
rainfall (mm)
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
9
10
11
12
months
Amd, 1995


Rainfall at Qasm, 1995
rainfall (mm)
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
months
Qasam, 1995


Rainfall at Shibam, 1995
rainfall (mm)
0
1
2
3
4
5
6
7
8
1
2
3
4
5
6
7
8
9
10
11
12
months
Shibam, 1995

Sheet1 Chart 38



Sheet1 Chart 37